Deliverable Report

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Description of the Deliverable:
This deliverables consist of an inventory report of the 'State of the Art' in Steam-, Audit- and Management Practices in the partner countries. Apart from that also (summarized) information was collected from 6 additional countries (via associate partner EnR) and via associate partners UNIDO.

Summary
The objective of this deliverable is to identify current practices and information that can serve as a basis for the development in the following work packages:
- WP 3: The in-depth steam audit methodology
- WP 4: The trainings and training materials

The information was collected using 3 main sources: Partners and associate partners (15), Enterprises (55), Energy auditors (45).

This inventory reports also contains:
- An overview or available Tools and Methodologies in the field of Steam and Auditing
- An overview of Training Materials and Information Sources
- Insight from (recent) literature on the decision behavior of industries and the strategic and economic benefits of energy efficiency and energy management.

WP 2 Inventory report State-of-the-Art

Netherlands Enterprise Agency

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1. General introduction

1.1 Method of inventory

This inventory report gives an overview of the State-of-the-art in steam use, energy auditing and management practises based on:

- Survey's at 8 partner countries and additional 6 associate partner countries
- Survey's at 45 energy auditors mainly in partner countries but also involved by associate partners
- Interviews at 55 enterprises in the partner countries

Apart from that relevant insights from (scientific) literature are included on Behavioural Change, Factors influencing energy efficiency (investment) decisions, Non-Energy Benefits and Benefits (and Cost) of Energy Management Systems.

2. Country Information

2.1 Industry and Energy Use

Steam use as percentage of overall industrial energy use

Table 1: Industrial energy and steam use

[PJ]	AU	CZ	D	DK	E	G	I	NL
Industry	336	339	2600	199	1060	717	1174	1213
Heat				66.8				
Steam	87	1.97[1]	500	20[1]	165[2]	25	218	308
%	25.9	0.6	19.2	10.1	15,5	3,5	18.6	25.4

1. Estimation 2. From proposal

Sectors and processes (main industrial users)

Sectors mentioned by the partner countries where steam is being used are: chemistry (incl. pharmaceuticals), mining, food & beverage (incl. tobacco), wood processing, textile, minerals (non-ferro) processing (incl. construction materials) and automotive. In the partner countries these sectors account for 25 up to 80% (on average 50%) of the total final energy use in industry. For Austria these sectors account for 95% of the industrial steam use where the paper and pulp sectors is the most steam intensive (66% of the final energy use in this sector is for steam). For the other countries this detailed data is not currently available.

Processes in which steam is being used vary widely from direct use in the production process, heating, washing, cleaning, drying, to frying, sterilization and baking. Widest use, based on enterprise interviews, is found in direct process (26%), drying (19%)and heating (water)(13%)

2.2 Steam Use in Industry

Number of installations

Table 2: Number of steam boilers in operation

[-]	AU	CZ	D	DK	E	G	I	NL

Installa-tions	2886	32000[4]/ 250[5]	5121[3]	4500[1]	15000[2]	456	1200[2]	3000[2]

1. 2006 2. Estimation 3 From proposal 4 Installed capacity > 200kW (2010) 5 Installed capacity > 1383 MW

Data on the number of steam installations in operation is hardly available or is outdated since no official registration is present in any of the partner countries. Only in the following cases number are available:

- Official inspection by government bodies e.g. labour inspectorate in Denmark in 2006. However currently inspections are being executed by authorized bodies and numbers are no longer registered or freely available.
- At emission authorities but then mostly starting from a specific installed capacity (CZ).
- Law for pressurized equipment. In Austria the exact number and specification of steam boilers, falling under this directive, is available. This doesn’t however cover the full number of steam boilers in operation.

In most of the partner countries however only estimates can currently be made on the number of boilers.

Type of boilers

Mostly mentioned are the fire tube boilers (95% in Spain, 50% in Austria) followed by the water tube boilers (15% in Austria). In Austria, were the most specific information is available, also electric boilers (467), high speed steam raising (105) and heat recovery boilers (74) where mentioned.

Type of fuel

Type of fuel depends from country to country but the use of (natural) gas is the most wide spread. For countries were specific data for steam use are available this is: 80% in Czech Republic, 45% in Austria and 90% in Spain. Other often mentioned fuels are oil, coal (mainly Czech Republic and Greece) and biomass or biogen fuels (40% in Austria and upcoming and growing in Denmark).

Life time

Again no detailed and recent data is available. Data from the Czech Republic (2009) show an average age of 16 years with 22% having an age of 20 years or more. In Austria, form a boiler data base for emission registration, almost half of the boilers had an age of at least 25 years. In the Netherlands, Denmark and Spain (experience) numbers, for the majority of installations, of more than 20 years are mentioned.

Energy use and potential

Based on studies (D, AU) and estimations (most of the other countries) the potentials in energy savings in total energy use for steam range from 6.6 to 11% (AU, D, NL,) up to estimations of 10-20% (S, CZ). Numbers for saving potentials for Austria only account for savings in steam production (6,6%) and not in use. For the Netherlands a distinction was made in steam production (2-3%) and steam use (7-8%).

Most promising measures (with the most potential) for steam systems mentioned are mainly heat recovery measures (exhaust, blow down and condensate return) and boiler optimization. However also operation and control measures offer (still) a high potential for (low cost) savings. Also distribution losses give rise for some saving opportunities. Distribution losses account for a drop in overall steam generation efficiency from, on average, 90% (at the boiler house) down to 65% (NL Best Practise Guideline Steam). Although more cost intensive, also replacement of (outdated and low efficiency) steam boilers by new steam boiler or alternative heat and heat generation sources (waste heat) offers a wide range of opportunities. For more detailed information see also the results for the enterprises interviews and energy auditor survey's.

In Portugal an extensive study was executed at 45 industrial enterprises covering 63 steam boilers in which the energy saving potentials for steam systems was assessed. In the table below a distribution over the different categories of measures and it's potentials is depicted.

Table 3 : Type of steam saving measures and their potential

Type of Measure	Representativity in terms of % of Total Energy Savings Potential identified in the Study
Procedures optimisation in steam boiler - Combustion efficiency improvement & Heat transfer surfaces cleaning	24,8%
Procedures optimisation in steam boiler - Improvement of boiler feedwater treatment (including boiler blowdown optimisation)	1,2%
Procedures optimisation in steam boiler and steam users - Improvement of equipments control and/or maintenance	12,0%
Implementation of an automatic system of oxygen trim control in the boiler	16,8%
Installation or improvement of thermal insulations - in fuel oil tanks, condensates tanks, boilers feedwater tanks, steam/condensates pipes, etc.	2,5%
Boiler blowdown heat recovery	2,3%
Heat recovery from boiler flue gases - installation of economisers and/or combustion air pre-heaters	40,1%
Boilers replacement	0,3%
Other measures	0,1%
TOTAL	**100,0%**

Check and audits

Check and audits on steam systems are executed regularly in all partners countries as a result of national and EU-regulation on a.o.:

- Pressure equipment
- Emissions
- Occupational health and safety regulation

Regularly checks are also performed to ensure proper and efficient operation. More specific details can be found in the section on the enterprise interviews.

Steam Experts and Expertise

Organisation of steam expertise

Steam expertise is in most of the partner countries not officially organized. In most countries energy consultants are organized via energy consulting associations. The highest level of organisation is found in the Netherland were an expert platform for steam exists: www.stoomplatform.nl. In Italy and Czech Republic a certification of energy auditors or energy management experts exists. These are able to also perform steam audits or registered with steam as a specialism.

Steam expertise is generally available at suppliers of steam systems and components like a.o. Bosch, Spirax Sarco who also offer trainings and courses and guidelines that are generally free available on the web.

Education and training

Only Denmark states the existence of a vocational education on steam i.e. a school for training boiler attendants. Italy is referring to several university grade education and training materials used in several Polytechnic Universities. Although not mentioned steam is very likely also one of the (basic) subjects in bachelor and master studies of Mechanical Engineering's in all of the partner countries.

The Austrian Energy Agency is offering, within the framework of the Klimaaktiv Climate Initiative, a one-day training on steam systems.

Several private providers and suppliers of steam equipment in the different countries are offering courses on steam and steam efficiency. Also the EUREM programme (European Energy Managers) is dedicating part of their courses on steam.

Steam expertise in enterprises

In most of the partners countries no dedicated steam experts are present in the enterprises. In Denmark and Germany enterprises that are using steam need to have a boiler attendant (DK) or someone with the proper qualification to operate and maintain the boiler (D) according to legal or regulatory requirements.

Responsibilities for the steam installations are generally at the process engineering or plant manager level (S). Expertise for operation is generally available at people from technical services department or is being hired (NL). The focus is however seldom on energy efficient operation of the steam system.

Key players in Industrial Steam (Force Field Analysis)

Mentioned key players in the field of industrial steam are:

- **Industrial enterprises using steam** with a low to moderate level of expertise
- **Boiler manufacturers** like Bosch, Certus, Balsmann a.o. offer equipment, expertise and information (guidelines, trainings, course and tools)
- **Technology (and equipment) suppliers** like Spirax Sarco a.o. offer equipment, expertise and information (guidelines, trainings, course and tools)
- **Contractors:** some offer steam saving measures as a package in energy saving contracting
- **Consultants:** offer consultancy and in some cases also implementation of saving measures
- **Energy auditors** to perform energy and/or energy management audits in a.o. the framework of the Energy Efficiency Directive or other currently existing national legislation
- **Sector organizations** with, in most of the partner countries, one of the roles to supply their members with information on energy efficiency
- **Expert platforms** with a role to maintain, exchange and supply knowledge. However hardly existing in the partner countries on steam specifically. But existent in general on the issue of energy and environment like the European Network of Environmental Professionals ENEP who is associate partner in the project.

2.3 Legislation and Support Programmes

Legislation and regulation (steam and energy efficiency)

Leading are the European Directives on pressure equipment (PED 97/23), energy efficiency (EED 2012/27) and pollution (IPPC 2008/1) and it's respective implementation in national law.

On top of that national regulations exist related to storage and use of flammable fuels (I, AU), occupational health and safety (NL, AU), emissions (NL, AU, G, CZ) and energy efficiency (I, G, NL, CZ). Several countries have special guidelines for the design and/or operation and construction and examination (D, CZ). Italy is the only country using the white certificate scheme of (tradable) certificates given proof of the achievement of end use energy savings through energy efficiency improvement projects and initiatives.

2.4 Auditing and Management Practices

Energy Auditing Practises

Energy audits are being executed, on a regular basis, in all partner countries although, up till the implementation of the EED in 2015, not always obligatory. Audits are mainly executed because of legal obligations (national law) (DK, NL, I, CZ) as obligation in a voluntary agreement schemes (NL) or as part of an energy management system (D, due to the high amount of ISO 50001 certifications). When obliged it is mainly for large enterprises (CZ, DK).

Implementation of measures following from the energy audits is obliged (to a certain extend) in countries with voluntary schemes (NL, DK) of because of legal obligations (NL, environmental act). Implementation rates om measures as a result of an audit are hardly known or monitored yet, this is likely to change after implementation of the EED (AU). In Germany however a detailed inventory was being performed in SME's that show implementation rates up to 42% of specific measures (organization measures) however e.g. process heat measures show a much lower implementation rate (17%). Some estimates where given of implementation rates between 20-50% (E). Based on the survey's executed at energy auditors implementation rate of 44% is given (implementation rate of economic viable measures one year after concluding the audit).

Management Practises

In all interviewed countries a wide variety of management system standards is certified for in industrial organizations. Most commonly used are:

- ISO 9001 Quality Management
- ISO 14001 Environmental Management
- ISO 22000 Food Safety Management
- ISO 50001 Energy Management

In the table below an overview of the Europe wide certificates for the commonly used standards is being given.

Table 4: Number of ISO certificates issued in Steam-Up partner countries and Europe

	ISO 90001	ISO 14001	ISO 22000	ISO 50001
Austria	4213	1172	93	109
Czech Republic	13229	5831	141	32
Denmark	1692	895	142	51
Germany	55363	7708	402	3402
Greece	5446	909	1354	25
Italy	168960	27178	1214	294
Netherlands	10433	2411	461	24
Spain	36005	13869	537	310
Steam-Up consortium	***295341***	***59973***	***4344***	***4215***
EUROPE	**483710**	**123849**	**10654**	**5526**

The ISO 50001 Annex B offers guiding how to integrate ISO 50001 requirements into management systems like ISO 9001, ISO 14001 and ISO 22000. Within ISO currently a High Level Structure for management systems is being developed this facilitating the integration of two or more management systems. Most commonly used is the integration within ISO 14001 where energy is identified as a significant environmental aspect. Some certifying organizations execute combined system audits for both ISO 50001 and ISO 14001.

Most commonly used assessment method to determine the economic viability of investments are Simple Payback Period (SPP), NPV (Net Present Value) and IRR (Internal Rate of Return). Especially when there is an internal rule to only implement measures with max. pay back periods SPP is considered sufficient to make a quick selection. For more detailed analysis, NPV and IRR is usually applied. TCO or LCC is very seldom used.

2.5 Stimulating Energy Efficiency

Non Energy Benefits

Except for Denmark, there is not much 'explicit' experience in including non-energy benefits in investment decision. When mentioned the focus is mainly on benefits on process improvements and sometimes cost for maintenance. Also is stated that most investment decisions are done because of production related issues (and not for energy efficiency).

Behaviour and energy efficiency

In several of the interviewed countries (DK, AU, Gr, NL, D) experience has been gained over the last 10-15 years on inducing energy efficient behaviour. This has given insights in the critical success and fail factors of energy efficiency programmes (incentives) and awareness raising campaigns a.o. gained from the European BEHAVE project, in which several of the Steam-Up partners participated.
Some examples:

- Post Denmark has worked with energy efficient behaviour and has demonstrated savings of approximately 20 percent of their energy consumption.
- In Germany the Hotel and Catering association (DEHOGA) informs about profitable Energy Efficiency measures for hotels and restaurants through its "Energy Efficiency Campaign".
- In the Netherlands a guide book was developed to induce energy awareness in organizations: "behavioral change in organizations".

No specific experience or projects are however know on inducing behavioral change in industrial organizations. Only in the Netherlands, within the voluntary agreement programme, a small scale pilot was done in raising awareness for energy efficiency at board room level.

3. Results from enterprise interviews and energy auditor survey's

3.1 Steam Use and Operation of Steam Installation

Steam use in general (Why is it used?)

- Steam in interviewed enterprises is used for processes (direct and indirect) (66%), utility (water, cleaning) (25%) and building (heating and humidification) (9%). Although alternatives for steam are assessed in 46% of the enterprises they are seldom implemented (4%).

Steam use and operation

- **Energy use** is known 'exactly' by 81% of and by estimation for 7% of the enterprises. However a considerable amount (12%) has no insight in energy use. In 36% of the enterprises steam use contributes to more than 25% of the overall energy use. 38% doesn't know or didn't had an answer.
- The **efficiency** of the steam boiler is well known (84%).
- **Fuel** used for the steam boiler is mainly gas (NG or LPG): 76% of the enterprises. Other frequently used fuels are: liquid fuels (6%), coal (5%) and biomass (5%).
- **Energy use** at the interviewed enterprises for steam production varies between 1 and 800 Gwh with a total amount at the interviewed enterprises of **4200 Gwh**.
- **Insulation** is stated to be 'good' in 40% of the enterprises. This can however in be questioned in 18% of the enterprises since insulation is 'as designed'. Only Czech Republic has a standard for steam boiler insulation which is followed by all Czech enterprises. For other enterprises only 13% knew the thickness of their insulation (varying between 5 and 10 cm).
- **Conductivity settings** are known by 30% of the enterprises and range between 200 and 7000 µS.
- Installation is **turned off** in 33% of the enterprises when no demand. When not turned off 58% of the enterprises can give a justification for that (24/7 operation, reduced pressure at idle mode).
- **The steam distribution system** is judged as operating 'good' in 35% of the enterprises. In 63% of the cases this is based on expert judgment or (legal) requirements and standards.
- **Steam traps** are (regularly checked) at 64% of the enterprises and when checked in 90% at a stated frequency;

Steam saving measures

- **General:** In 75% of the enterprises measures are already taken, ranging from (low cost) operational measures to complete revamping of steam generation and production lines. In 4 enterprises no measures were (yet) taken due to a.o. lack of budget or not being able to quantify savings.
- **Taken measures** (collected in enterprise interviews): There is a high focus on (technical) heat recovery measures (65%) and less on good housekeeping (18%).
- **Taken measures** (collected at auditor surveys): There is a high focus on steam production measures (36%) and less on insulation (20%) and steam distribution (29%). Steam use and replacement of steam by hot water, CHP or steam generator gets least attention (15%). It is also striking that operational control measures (control, pressure settings and maintenance) only account for 15% of de measures.
- **Not taken measures** (energy auditors): steam production pops up highest (43%) followed by steam replacement, steam use and steam distribution (all 15%). If asked at enterprises what

measures still can be taken distribution and heat recovery measures score highest (resp. 31 and 32%). Operation and control measures are mentioned significantly less (resp. 20 and 17%).

- **Advised measures** (by auditors): focus is merely on steam production measures (38%) and distribution (32%) and less on steam use (9[1]-10[2]%), steam replacement (8-12%) and insulation (13-17%).

Table 5: Numbers of individual measures

Taken	Not taken	Advised
Insulation (25)	Economizer (6)	Condensate return (21)
Economizer (14)	Blowdown (6)	Blow down (12)
Steam Traps (14)	Steam Use (6)	Economizer (10)
	Condensate return (6)	

- **Concluding:** focus seems to be mostly on steam production measures (taken, not taken and advised). Furthermore its seems that measures on use and replacement are better noted when they are not taken although . Operational measures as well as measures on steam use and steam replacement have lower attention.

Energy use, energy costs and saving opportunities

- **Cost steam production:** in 20% of the enterprises the total cost for steam production are not known. When know the costs range over the enterprises form < 0,1 to > 10 M€.
- **The total cost** of operation, maintenance and inspection are known in 31% of the enterprises. When not known the arguments are that these are internals cost or part of the maintenance budget.
- **Cost reduction:** in 77% of the enterprises there is the feeling that the cost for steam operation can be decreased with at least 10% (46% of the enterprises).
- **Awareness of savings:** In 40% of the enterprises one knows how many energy can be saved by taken measures and in 31% also the management is aware of this. This doesn't guarantee that economical viable measures are taken. Too long pay backs, lack of resources and (perception of?) involved risks are arguments mentioned for this.
- For **information on saving opportunities** enterprises highly rely on energy consultants (70%) and equipment suppliers (33%). Websites and sector organizations are relied on less (16 and 25%). Currently 10% gets their information form external steam experts.

Check and audits

- **Steam boilers** are checked in 98% of the enterprises and in most of the enterprises on a yearly basis or more frequently. Checks are done by internal or external experts (50/50). In most of the cases (66%) checks are done by both an internal and external expert. In only 16% just by an external expert.
- The **distribution system** is checked on regularly in 61% of the enterprises and when checked this is in 60% with a frequency of 1 or more times a year. In 20% this check is daily (visually).

[1] Asked for measure where generally advised on
[2] Asked for last three recommended measures

- **Type of checks:** When checks are performed this is in 80% of the enterprises on emission numbers, boiler water quality and integrity pressure equipment. Steam traps are checked on in 53% of the enterprises and energy saving opportunities in only 34% of the enterprises.

3.2 Key players for steam and energy efficiency

Influence on energy efficiency

- **General:** Management (this includes all levels of management) is considered to have the highest (direct or indirect) influence on energy efficiency (39%), followed by technology and engineering (24%). Production and maintenance are less often mentioned (13 and 9%).
- Asked for the **kind of influence** however, maintenance is mentioned 33% of the cases, followed by decision making and project definition (both 15%).

Awareness raising and involvement

- **Awareness raising:** When an answers was given in 37% of the answers training was mentioned as means to raise awareness followed by monitoring (18%). In 44% of the enterprises no answer was given or people weren't made aware.
- **Involvement of people** (who are considered to have influence) in the improvement of energy efficiency takes places within the management team (16%) or by proposing improvements (to the management team) (10%). Involvement via e.g. an energy action team seems less common (5%).
- **Top management** is involved in 58% of the enterprises and then mostly via the way of making the decision for approving proposals for improvement (52%).
- Fulfilment roles, tasks and responsibilities (related to energy efficiency) are only checked in 27% of the enterprises most of the time by management (30%). In only one (1) case this was laid down in the job description.
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3.3 Energy Auditing Practises

Energy Auditing

- **General:** In 73% of the enterprises energy audits are being performed on an regular basis.
- **Motivation:** Cutting energy costs is in 67% of the enterprises mentioned as reason, followed by legal obligations (47%). Cutting energy costs is by 57% of the energy auditors mentioned as main reason, followed by legal obligations (36%).
- **Client for audits:** In 47% top- or higher management is the main client of the energy auditor. Followed by the energy manager (27%) or energy representative (18%).

Audit on Steam System

- **General:** When performing an audit in 86% the steam system is included in the audit. Main focus is on the steam production (97%), followed by distribution (92%) and use in production (79%).
- **Arguments for omission:** not doing distribution because it is considered negligible referred to production. Not doing steam use because essential for production and therefore no priority.

Involvement of management and personnel

- **Involvement:** energy auditors state that the energy manager is almost always involved (88%). If not, always the production manager is involved. In 25% of the audits no people from technical services and/or process engineers seem to be involved. This is mainly in SME's but also in EIE (9%).
- **Top (or higher) management** is in 13% of the enterprises involved in the auditing process (when asked which people are involved). Energy auditors state that in 27% of the audits top management is involved. Asking explicitly (Is top management involved?) 38% of the enterprises state that top management is involved. This in spite of the fact that in 75% of the enterprises top management/owner makes the decision on implementation of saving measures.
- **Ways of involvement top management:** When involved this is in 62% at the end stage (pursuing actions, making decisions, analysing results or reporting). 10% of the enterprises doesn't consider that taken part in the process in the end or after reporting as real involvement.
- **Lower management** involvement (energy, production,…) is generally higher (56% stated by enterprises and even 95% stated by energy auditors).
- **People with influence** on the actual implementation are only in 29% of the enterprises involved in the auditing process. When not involved only in 42% arguments are given.
- **Arguments to involve people** in general is their (technical) knowledge (25%) (63% of the enterprises didn't respond). Therefore people from technical services (incl. maintenance) are highly involved in audits (49% stated by enterprises and 72% stated by energy auditors). Engineers and technologists are involved less often (15% by enterprises and 47% stated by auditors).
- **Other staff** (not energy related) is hardly involved (9% stated by enterprises and 14% stated by energy auditors). Sustainability managers are only involved in the bigger teams >= 5 and always in combination with (PM, EM and PE).
- **Effect of top management involvement** seems to be positive on the involvement of other disciplines. For a 'team' without management on average 1,8 additional people are involved. For a 'team' with management involvement 2,6 additional persons are involved. This is a participation increase of average almost 50%.

Audit Results and Reporting

- **Results:** In 48% of the auditor cases the audit results consist of more than an identification of saving measures. In 27% an implementation plan was offered and in 25% an M&V plan is included. In 11% of the cases both were included. Implementation is in **one (1)** case accompanied with a risk assessment of the identified measures.
- **Reporting:** Most of the auditors offer a report (30%) and/or a presentation to higher management (27%). 18% is doing both. 43% seem not to use one of the above mentioned ways of reporting. It is not stated what they use instead (only a list of measures?, red). Almost 80% of this respondents didn't include implementation and M&V plans to their audit results.

Follow Up of Audits

- **Follow up** on audit results is stated by 64% of the enterprises. When followed up this is mainly done internal (74%) very often in cooperation with external support. In 17% of the enterprises this follow up is only taken up externally.

- **External follow up:** energy auditors are being faced with numerous challenges. Lack of budget or profitability is mentioned in 15% of the cases. Also striking are the challenges related to priority (time, interest, priority) that counts for 28% of the cases.
- **Viable measures:** when following up (by auditors) 44% of identified viable measures (SPP < 2 years) are being taken after 1 year. If not taken in 65% auditor gets to know why. Main reasons mentioned are lack of budget (41%), not accepted by management (17%) or lack of economic benefits (15%) **(?** red. **)**.
- **Implementation plans** are made in 60% of the enterprises. In 10% of the enterprises this is explicitly stated no being done.
- **Allocation or resources** (time, capacity, money) is only in 27% of the enterprises organized.
- **Facilitation for implementation:** asked for what kind of methods the auditors use to facilitate enterprises, support in evaluating benefits (18%), support implementation (12%) and involve management (9%) are mentioned. Alignment with company plans and activities to identify real company needs was also mentioned some times.
- **Needed to enhance implementation:** support to compensate risk of implementation was mentioned by 15% of the auditors. Followed by awareness raising of opportunities (11%) and involvement of management (9%).

3.4 Monitoring and verification

- **EnPI's** are defined in 48% of the enterprises. When defined this is in 73% based on use per unit.
- Verification: Energy measures are verified in 46% of the enterprises. When verified this is mostly done by monitoring, measuring or metering (41%).

3.5 Management Practises

Management priority

- **Management priorities:** In 47% of the enterprises the reduction of energy use and costs is stated to be a management priority. In 59% this is because of economic reasons and since it affects costs. In only 11% of this enterprises this is because of environment and/or CSR.
- **Enablers to reduce energy use:** Asked for what would be needed to reduce energy use and costs only 22% enterprises come up with an answer. Where 42% mentioned grants and subsidies.

Management systems

- **Management systems (MS):** 91% of the enterprises have a management system like ISO 90001 (35), ISO 14001 (35), ISO 50001 (8), OHSAS 18001 (8) or ISO 22000/HACPP/IFS (10). ISO 9001 and ISO 14001 are implemented at almost 64% of the enterprises. ISO 50001 at 14% (an additional 7% is works on it).
- **Certification:** 35% of the enterprise state the system is being certified (2% on plant level).
- **Energy included:** In 13% of the enterprises energy is addressed in the MS (mostly 14001).

Evaluation of investments

- **Methods general investments:** Asked for financial evaluation methods in general SPP scores the highest (42%). Followed by IRR (29%) and NPV (14%). LCC or TCO is only used in 5% of the enterprises. In 18% only SPP is used as evaluation method.

- **Methods EE investments:** 64% of the enterprises use SPP (together with other methods) to asses profitability of energy efficiency measures. In 44% of all enterprises only SPP is used for evaluation;
- **Energy efficiency investments** are evaluated in the 'same' way as general investments in 33% of the enterprises. But they require a lower SSP (33%).
- **Non-energy benefits (NEB)** are accounted for in 53% of the enterprises. When accounted for environment and CO2 emissions show the highest scores of attention (28%). If not, only few explanations are given of which one is interesting. This enterprise thinks 'the other way round' which is interpreted as 'accounting for the energy benefits in regular (strategic) investments'
- **Non-energy benefits (NEB) in investment decision** are only in 38% of the enterprises accounted for. Difficulty in quantification was the most heard reason for not doing so. Auditors state that in 90% of the cases also other benefits apart from energy are included in the evaluation.
- **Categories of NEB's:** Improvement in productivity is for 62% of the cases mentioned as important (non-energy) benefit. Influence on (external environment) is with 24% the second mentioned. On average the significance of these benefits are rated at 7 (scale 1-10) referred to the significance of the energy benefit. The spread is however large ranging from 2 to 30.

Profitability as investment criterion

- **Profitability** doesn't seem to be decisive in the implementation of energy efficiency measures, although the opposite is consequently stated. This can be **concluded** from the following.
  - Although assessed as being profitable (based on the most widely used criterion of SPP) only 56 % of these measures are actually taken).
  - After one year 44% of viable measures (SPP < 2 year eq. IRR = 50%) are implemented. Main reasons mentioned are lack of budget (41%), not accepted by management (17%) or lack of economic benefits (15%) **(?)**.
  - Being not profitable (based on the same criterion) doesn't withhold enterprises to implement measures. 63% of the auditors state that although not assessed as profitable measures are still taken.
  - Having a closer look it shows that feasibility is only in **one (1)** case a reason to reject measures. In 53% of the enterprises (analysed) measures are being rejected with as main argument (57%) profitability. When profitable in 30% of the enterprises the measure might still not be taken.
- **Profitability assessment:** If profitability is a 'knock-out' criterion one would expect that the profitability would be accounted for over the lifespan of the investment. The SPP methodology (which is widely used) only accounts for the benefits in the timespan in which the investment is payed back. IRR, NPV and in a wider extent TCO and LCC do account for costs and gains over de total life span of the investment. Their use is however considered complex i.r.t. SPP. Moreover SPP is in many organisations embedded in the internal (management) procedures for investment decisions.

4. Collection of Tools, Methodologies, Training Materials and Information Sources

4.1 Information collected form partner inquireries

In total a set of 42 different tools, methodologies, training materials and information sources were identified which have a national as well as a European basis. Important sources where a.o. thU projects and initiatives like Einstein, Greenfoods, CARE+ and the EUREM programme. The identification didn't however have an exclusive European focus and therefore also materials from non-European origin are included. The overview includes materials from a.o. the American Society of Mechanical Engineers, Canadian Industry Program for Energy Conservation and the United Nations Industrial Development Organisation. The latter has developed a complete package of training materials for Steam System Optimization (SSO) that is globally used.

A first assessment of the materials shows the following:

- Only a few cover the full range of steam- and audit subjects required for this projects. Only one, the UNIDO SSO package, seems to cover all subjects except the non-energy benefits.
- The focus of the remainder of materials is either on steam (technical) auditing or energy auditing in general.
- Some subjects get only few attention in the existing materials. More specifically these are for:
  - Steam auditing: good housekeeping and monitoring.
  - Energy auditing: management commitment, tasks and responsibilities and financial assessment;
- Non energy benefits are only addressed marginally or in specific developed tools.
- Some tools materials only address specific subjects, e.g. calculation of stand by losses, that might not be addressed in detail in other materials.
- Other tools and information that came up during the inventory and that might be of use e.g. a Calculation Tool Assessing the Impact of Various Energy Conservation Measures on Financial Accounts.

4.2 Interesting projects and websites to follow

- **Energy Audits and Energy Management:** EU funded project to share best practices and knowledge sharing opportunities to support Member States in the implementation of Article 8 of the EED. www.energy-audits-and-management.eu
- **The Sectoral Platform in Chemicals for Energy Efficiency Excellence** (SPiCE^3), co-funded by the European Commission, aims to boost energy efficiency across the European chemical industry, http://www.spice3.eu
- **European Energy Manager** EUREM is a standardized training of further education, that enhances the skills of technical experts in the field of energy efficiency improvement. The EUREM programme is offered in 30 countries and covers nearly all energy-relevant issues which can arise in companies. www.eurem.net

- **Einstein-Project** EINSTEIN is a methodology for the implementation of a holistic integral approach to thermal energy auditing in industry and in large non-industrial users such as hospitals, office buildings or sports halls. In other words, EINSTEIN allows for the development of strategies for the reduction of energy demand and operating costs by heat recovery and process integration and by an intelligent combination of existing affordable heat and cold supply technologies, under the given economic constraints. See: http://www.einstein-project.eu/ and https://www.einstein-energy.net/

5. Non-energy benefits

5.1 General

When energy consultants and industrial companies discuss energy efficiency (EE) projects the potential energy savings are quite naturally in focus, but frequently the value of secondary effects of these projects is just as high or even higher. Such secondary effects are typically referred to as non-energy benefits – NEBs. Examples are reduced waste, reduced emissions, reduced maintenance costs, a better working environment, and reduced production downtime.

NEBs are traditionally not included in the economics of energy efficiency project implementation since there is no commonly recognised method for calculating their value, nor has the area been prioritised. However, research indicates that if NEB are included, the true value of the energy efficiency projects might be up to 2.5 times higher than if looking at the energy efficiency improvements alone. A striking example is shown in the figure below where energy saving in a project, that started as an energy saving project, only account for 10-15% of the total (calculated) cost savings. Pay back time could therefore be reduced form 3,6 year down to 0,5 years.

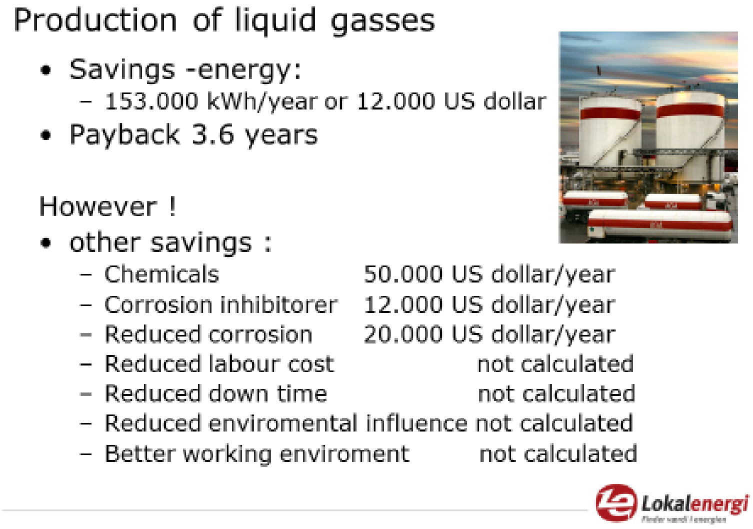

Figure1 : Example of a NEB case

5.2 NEB web-based Tool

Access to information on NEBs and their size might thus lead to higher acceptance and implementation of energy efficiency projects. In order to make this information accessible in Denmark a project was developed to collect experiences working with NEB's in enterprises in a web based tool. Project partner Aura is project manager of this project. The web-based tool is available (already partly in English) at: http://neb.teknologisk.dk/.

6. Insights from literature

The Steam-Up project aims to bring energy efficiency on the decision level of organisations and facilitate organisations to build an energy efficiency 'culture'. In order to do so some concepts were already brought up to use for this e.g. Energy Management Systems and the Non-Energy Benefits.

However to be able to intervene at decision level insights are needed on what factors are influencing the decision making and behaviour related to energy efficiency. Below some insights from recent literature are given to be able to address these issues in a constructive way in the Steam-Up project.

6.1 Making the business case for energy efficiency projects

The Carbon Trust (UK) designed a management guide "Making the business case for a carbon reduction project"[3] on how to develop a solid business case for energy efficiency project. Target groups for this guide are energy, environmental and facility managers as well as people from engineering. The guide is aiming to "help these people to ensure that projects for cutting energy costs get a fair hearing and the best possible change of implementation". The guide offers a stepwise approach how to build the business case for your project and how to influence the (various) people who have a role in the decision making process: in most of the organisations this is not solely senior management. Subject being dealt with are: influence and reputation, building the case (with reliable data, benefits - financial and additional -, implementation costs, risks analysis (technical, operational, market), drafting and presenting the proposal.

6.2 Energy management implementation and company competitiveness

Costs and benefits of ISO 50001 implementation

Since its publication in 2011 almost 6800 organisations worldwide have implemented the ISO 50001 Energy Management System Standard. Although considered being the best (structural and systematic) way to reach the energy efficiency targets of organisations only minimal research is being done on the cost and benefits of implementation of ISO 50001. Within the US Superior Energy Performance (SEP) Programme, which asks for ISO 50001 implementation and certification, a survey was done[4] at nine facilities that are part of the SEP. Based on that it could be concluded that *"Implementation of ISO 50001 coupled with SEP energy performance targets results in **quantifiable and significant energy and energy cost savings** for the nine facilities"*. Based on the cost for implementation, mainly cost for internal staff, purchasing monitoring and metering equipment and certification, a payback period of (on average) **1.7 years** for the nine facilities was calculated.

Energy management and competitiveness

An Australian publication that was made by a.o. the Australian Department of Industry[5] offers a methodology to **raise energy efficiency to strategic level** by assessing the impact of energy savings on (future) financial performance. By using the EBITDA (Earnings Before Tax Depreciation and Amortization) as a reference the impacts of energy savings om (future) company competitiveness was assessed for 50 large industrial enterprises. Main findings of this study are:

- Most companies could increase their EBITDA by around 5% if they improved their energy performance to best practise.

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[3] Making the business case for a carbon reduction project, Carbon Trust (2013)

[4] Therkelsen, McKane, Sabouni, Evans, Scheihing (2013), Assessing the Cost and Benefits of the Superior Energy Performance Program, Lawrence Berkeley National Laboratory, United States

[5] McCoy, Denis, Skarbek (2014), Energy Management and Company Competitiveness, Climate Works Australia, Australia

- Based on future energy price scenario's 58% of the companies are likely to be highly impacted by future energy price rises.
- Improving their energy performance this companies could help alleviate the increase in energy costs by about half.

6.3 Non-energy benefits and decision making

Plenty publications are known on non-energy benefits and the way they could enhance the implementation of energy efficiency projects and measures. Focus for this purpose was on several recent publications that make the connection between NEB's and their relation to investment behaviour[6] and calculations[7].

Observations

Based on a.o. existing literature on investment behaviour for energy efficiency some of the following observations were noted in the mentioned publications:

- Based on the traditional approach of considering firms as being profit-maximising, when using the NPV method, the discount rate used for projects should be based on each investments risk level. However for investments in energy efficiency this has proven not to be the case. Energy efficiency projects are rejected even though they should be considered as profitable.
- Empirically, energy efficiency investments are considered as non-strategic or only moderately strategic. In the meantime, it is noted that profitability has an important role in the decision-making process, although not a decisive one, and that it is the most strategic investment who wins the internal competition.
- Empirically testing of decision making models for (energy efficiency) projects proof that the first phase (opportunity identification) is found to be essential for an investments proceeding.
- The quality of calculating investment (based on pay back) is not as high which as is when calculated with NPV. The financial importance of the adoption probability of an investment can therefore be questioned.
- Lack of a strategic approach is one of the main factors inhibiting energy-efficiency investments in general. Notably, the strategic dimension in a company is the means for how companies should focus their activities in a time-span of several years, while investments in energy-efficiency measures, are often taken on an operative level.

Suggestions

From the review of NEBss and the investment behaviour the following suggestions are made by the author(s):

- The concept of NEBs should be considered as the most adequate concept to use in an industrial context and can be defined as the benefits related to industrial energy efficiency investments, beside energy savings, that are quantifiable at a certain level and arise at some point in time.
- Including quantifiable NEBs in the evaluation process can increase the priority level for energy-efficiency investments.

[6] Rasmussen (2014), Energy-efficiency investments and the concepts of non-energy benefits and investment behavior, ECEEE 2014 Industrial Summer Study, July 2014, Papendal, the Netherlands

[7] Nehler, Thollander, Ottosson, Dahlgen (2014), Including non-energy benefits in investment calculations in industry – empirical findings from Sweden, ECEEE 2014 Industrial Summer Study, July 2014, Papendal, the Netherlands

- NEBs of a low quantifiability level, especially those of a strategic character, can serve as extra arguments at a later step in the decision-making process to select between similar investment opportunities.
- Including quantifiable NEBs may increase the reward from energy-efficiency investments and increase the value of investing today, overcoming known barriers such as uncertainty, irreversibility and technical risk, as well as reinforcing driving forces such as a green public image and improved working conditions.
- By defining and categorising NEBs according to their level of quantifiability and time frame, they can be included in the decision-making process at several stages and altogether increase the probability for adopting energy efficiency investments. Hence, the concepts of NEBs and investment behaviour can be integrated and thereby contribute to improved energy efficiency.
- Based on[v] the conclusion can be drawn (red.) that inclussions of NEB's in the decision process should be as early as possible. The author(s) state "…building up knowledge on NEBs may have large contributions in the future for measures that may not even "survive" the first step".

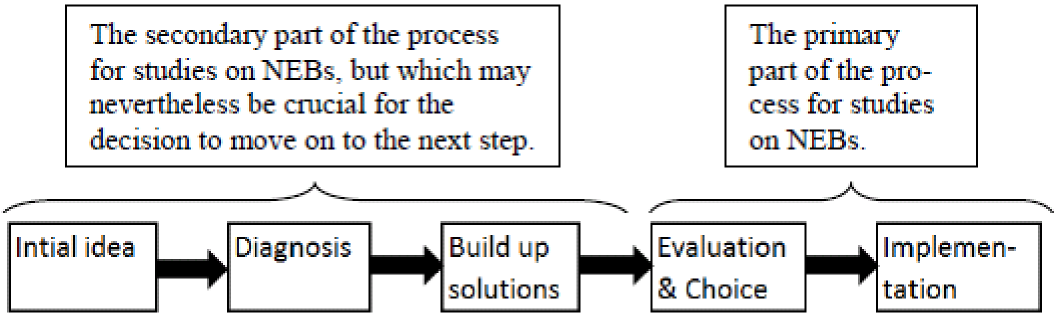


Figure 2: The inclusion of NEBs in relation to the investment decision-making model by Cooremans (2012)

6.4 Factors influencing decision making

Main factors that have an influence on the (investment-) decision making process of energy efficiency projects and investments are well described in a publication of the UK Department of Energy & Climate Change[8]. Main findings and recommendations from this survey are described below.

Observations

- Investments in energy efficiency appears to require high rates of return, sometimes much higher than other investments with comparable risks ("energy efficiency paradox"). Suggested reasons for this are: **perception of risk**, unwillingness to replace equipment, energy efficiency not being a **strategic issue**, a host of various **"hidden" costs** and businesses not being rational profit-maximisers.
- **Hidden costs:** cost of capital or the loss of productive capacity while technology is upgraded erode potential savings to the point where it makes no sense to invest unless returns are very high.
- The **strategic value of energy efficiency** is likely to be a key influence for investment decisions rather than profitability. Unprofitable investments will be taken if they can be shown to be strategic.

[8] Centre of Sustainable Energy and the Environmental Change Institute, University of Oxford (2012), What are the factors influencing energy behaviours and decision-making in the non-domestic sector?, United Kinggdom

- **Investment decision-making** is in general a three step process. Noticing the opportunity (step 1) and creating a list of options (step 2) are influenced by a range of processes and procedures including the attitudes and values of individuals,.. and the structure and capacity of the organisation. Choosing between options (step 3) using financial criteria receives most attention.
- Efficiency savings are framed as a **"gain"** what raises a barrier since organisations are found to devote more resource to **avoiding losses** rather than making gains. Efficiency investments can only offer a theoretical gain with a risk attached and organisations are also risk averse.
- Energy consumption is **invisible to senior managers** because it is the responsibility of operations and facilities managers. In large organisations they will be some distance from senior management.
- Energy efficiency investments are **classified as maintenance costs** rather than investments in productive capacity. They count against profit on the balance sheet as opposed to a classification as an investment in productive capacity which would count as an asset and therefore preserve profit.
- **Access to capital** is seen as a key barrier for efficiency investment. Some studies argue that when energy efficiency is reconfigured as having strategic value, access to finance becomes easier.
- **Non-energy benefits** of energy efficiency are critical to raising the strategic value of energy efficiency.

Implications

- Not only focus on economic arguments when talking about energy efficiency but also considered the wider context of procedures, norms, rule of thumbs, hierarchies, culture, friendships and market pressure that influence energy efficiency decision making.
- Focus on the **system maintaining the barriers** rather than removing individual barriers.
- There needs to be an increase in enterprises perception of the **strategic importance of energy efficiency**.
- Raising salience of energy use by institutionalizing it with help of an **Energy Management System**.
- **Reframing energy efficiency** as a strategic benefit that has a positive contribution to business performance. This can be done by combining economic considerations with additional benefits.
- There needs to be more focus (and **involvement of management**? red.) on the first steps (noticing the opportunity and listing the options) of the decision making process. Since there is not much clearness on when and whether an efficiency opportunity becomes salient to an organization.
- Don't forget **individuals and groups**. Individual believes, attitudes and values play an important role. Especially those of senior managers that shape the strategy of the organization. Target **key individuals** in organisations via networks and peer support mechanisms to influence decision making.

6.5 Drives for energy efficiency investments

More recently the Energy Efficiency Financial Institutions Group published "How to drive new finance for energy efficiency investments"[9]. This gives a god insights in the drives affecting demand for energy efficiency investments.

Observations

The study identified key drivers affecting demand for energy efficiency investments. The top 5 for large energy intensive enterprises:

- Energy Efficiency **Returns** (profitability)
- **Price** and Volatility of Energy
- Clear **Business Case** and Baseline
- Limited Business Interruption **Risk**
- **Awareness** at Key Decision Maker Level, Leadership and Human Capacity

Other interesting drivers highlighted by the interviewees were:

- Degree of Integration of EE in Business-as-usual (rank 8)
- Use of ISO 50001/Energy Management Systems (rank 10)

Recommendations

The report elaborates in detail on recommended activities to address the identified drives making a distinction in whether they should be market-led or policy-led. Below a high light of the market-led recommended activities are listed:

Driver: Clear Business Case and Baseline

- Development of guidelines for energy efficiency opportunity report connecting to energy audits with internal stakeholder buy-in, "finance ready" and fitting the template used by the Executive Management board.
- Anonymised data base of energy intensity in order for industries to be able to benchmark themselves, following the example of five identified international databases.
- Improved Measurement and Verification Standards for Energy Savings
- More case studies and best practice circulated among company segments and Member States

Driver: Energy Investment Returns

- Recognising the multiple energy and non-energy benefits of energy efficiency
- Use NPV and life-cycle costs to take into account long-term savings instead of simple pay-backs

Driver: Appropriate resourcing for Energy Efficiency

- Training and quality certification processes for energy auditors in order to high quality deliver energy audits that can be used by financiers
- Identify "tool-kits" to connect and replicate Energy Efficiency measures internally among the individual plants within a corporate group

Driver: Awareness at key decision maker level

- Improve Energy Audit so that it is more "executive" and delivers more into a key-decision maker/ executive board level context
- Energy audits should be (mandatorily) presented at board-level based upon guidelines as to what needs to be assessed and included in that board-report

Driver: Use of ISO 5001/Energy Management System

- Show the value of a structured framework for demand side energy management can have for all users

[9] Energy Efficiency Financial Institutions Group (2015), Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments

- Energy Management Systems are a key tool for large companies to integrate energy efficiency into its processes, increase visibility and raise priority

Driver: Access to capital

- Ensure that accounting treatment deals with energy efficiency investments as assets whose value are reflected and then depreciated over useful life (ie those which generate the energy savings) as opposed to one-time costs.

6.6 Influencing human behaviour

Theory

A well know and validated model for building an intervention strategy on human behaviour is that of Green & Kreuter. This model starts at the end by determining the wanted results in our case energy efficiency improvement. Based on that (step 1) the relevant changes in behaviour and environment (to reach the determined result) have to be diagnosed. In step 2 the determinants that for the behavioural change are assessed. These are the following factors:

- Factor 1: **Motivation:** The behavioural change (or new behaviour) must be wanted: people must have a motivation for the new behaviour.
- Factor 2: **Enabling**: The behaviour must be facilitated: people must be facilitated to perform the new behaviour.

1 and 2 induce the behavioural change, but a third factor is needed to continue behavioral change:

- Factor 3: **Reinforcement**: The behaviour must be automated.

Examples

Examples of the different factors are:

- Motivating factors: Knowledge (people have to be aware), Attitude (weighing of pro's and con's), Social pressure (norm) (do what others do.)
- Enabling factors: Financial resources, Technical resources, Organisational resources, New skills
- Reinforcing factors: Feedback of peers, Advice of experts, Feedback of authorities

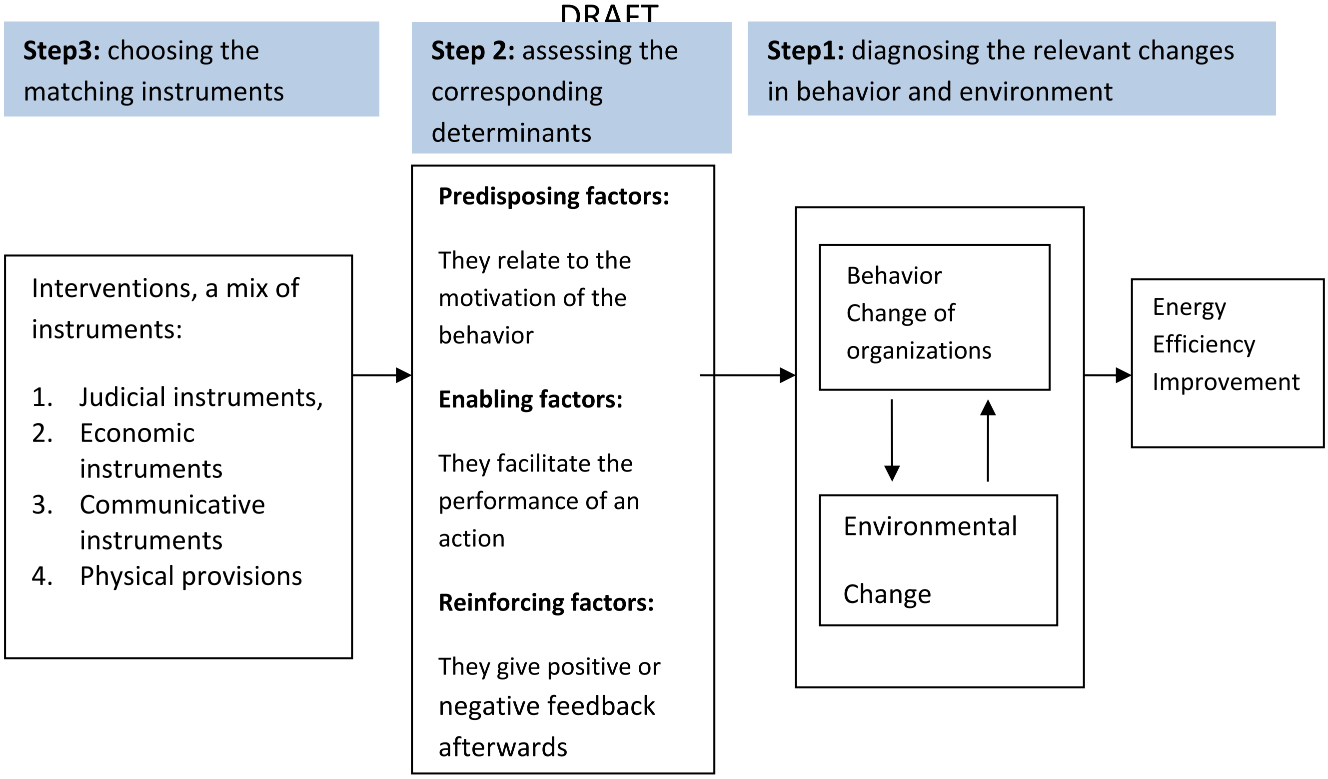


Figure 3: a model for developing an intervention strategy

Deliverable Report

Grant Agreement number: 649867

Project acronym: STEAM UP

Project title: Steam and Management Under Pressure

Funding Scheme: Horizon 2020

Date of latest version of Annex I against which the assessment will be made:

Deliverable Number: Deliverable 2.4
Deliverable Title: Inventory Report 'State-of-the-Art' on Steam, Audits and Management Practices: Appendices

Name, title and organisation of the project's coordinator:

Mr. Michiel Steerneman, Industrial Energy Experts

Tel: +31 6 51518128
E-mail: michiel.steerneman@ieexperts.nl

Description of the Deliverable:
Appendices to the Inventory Report 'State-of-the-Art' on Steam, Audits and Management Practices

2. Summary

The following appendices are included:

Appendix A: Questionnaires and Templates

Appendix B: Country Reports

Appendix C: Country Reports Associate Partners

Appendix D: Results Interviews Enterprises

Appendix E: Results Survey's Energy Auditors

Appendix F: Collection of Tools, Methodologies, Training Materials and Information Sources

3. Appendix A: Questionnaires and Templates

A.1 Questionnaire for Steam Up Partners

QUESTIONS

Industrial enterprises

1. How many industrial enterprises are active in your country? Please give a division per sector.
2. What is the (estimated) total energy use of the industrial sector in your country?
3. Give a short description of the type of industrial sectors active in your country.

Installations

1. How many steam boilers are in operation in your country and what is the installed capacity? (source)
2. Can you specify in type of boilers (water tube boilers, high speed steam raising, fire tube boilers,…)?
3. Can you specify in fuel type (gas, oil, electric, biomass)?
4. Can you specify in life time of the steam boilers (<10 years, between 10 and 20, >20 years)

Sales figures and developing trends

1. How many steam boilers are being newly installed on a yearly basis (new or replacements)?
2. Is the amount of steam boilers growing, stable or shrinking? (Historic developments)
3. How can growth, status quo or shrinking be explained?

Energy use and potential

1. What is the total energy use for industrial steam production in your country (PJ)? (source)
2. What is the percentage of total industrial energy use? (source)
3. Is there any information of savings potential through:
    a. Studies,
    b. Estimations,
    c. Investigations (on-site)
    d. …
4. Based on the above what is the estimated saving potential country wide (in % and (P)J)?
5. Based on the above in what sector(s) is/are the highest impact (in % and (P)J) being expected? (production and demand side)
6. Based on the above in what processe(s) is/are the highest impact (in % and (P)J) being expected?
7. What are the most promising steam saving measures that (still) can be taken?
    a. Heat recovery (exhaust, blowdown, condensate return)
    b. Operation (operation pressure, stand still, idle mode (no demand))
    c. Control (automated blow down, exhaust oxygen,…)
    d. Distribution (steam traps, control and design of heat exchangers,…)
    e. …

Sectors and processes (main industrial users)

1. How is the energy use distributed over the specific industrial sectors (pulp and paper, chemistry, food processing, wood processing, textile processing,…)?
2. How is the energy use distributed over the specific processes (drying, evaporation, distillation, heating/boiling)?
3. How are enterprises organised over sectors, are there specific sector organisations in place?
    a. What is their main objective?
    b. How do the contribute to the subject of increasing energy efficiency at enterprises?

Legislation and regulation (steam and energy efficiency)

1. What national legislation and/or regulation does apply when it comes to steam production and steam use? (emissions, maintenance, pressure equipment directives,..). Please specify (name, main obligations, enforcement and checking (audits)
2. What national legislation and/or regulation does apply when it comes to the efficient use of energy? ,..). Please specify (name, main obligations, enforcement and checking (audits)
3. Are there any (national) standards for (efficient) steam boiler operation and design?
4. Are there any support programmes from national or local government to stimulate the rational use of energy and/or steam?
5. Are there any financial instruments and or programmes rom national and/or local governments to support he rational use of energy and/or steam (subsidies, fiscal and financial instruments, bank guarantees, revolving funds, green loans,…)

Check and audits

1. Are steam boilers checked on a regular basis and if yes on what frequencies?
2. If a regular check is being performed what is being checked on?
    a. Emission numbers (O_2, NO_x,…)
    b. Boiler water quality and composition
    c. Integrity of pressure equipment
    d. Energy saving opportunities
    e. Steam traps
    f. …
3. Can you indicate specific steam auditing tools, practises and or methodologies? Please specify using the **A. Template for Tools and Methodologies.**
4. Can you indicate specific information (guide books, websites, factsheets, trainings…) on steam use and steam efficiency? Please specify using the **B. Template for Information Sources and Training Materials.**

Steam Experts and Expertise

1. How is the conservation and education/training of steam expertise 'organized' in your country?
    a. Are there expert platforms, associations, website, or others? Please specify.
    b. Are there dedicated educations (vocational, university,…), trainings, courses and/or workshops available in your country? Please specify type and (public and/or commercial) organisation(s) where education, trainings etc. is available.

2. Can you give an indication of the level of steam expertise within industrial enterprises using steam? Please specify.
    a. Do enterprises have dedicated steam experts?
    b. Who is responsible for the steam installation in the industrial enterprises and what is his/her level of expertise in steam production and use for industrial purposes?
    c. Is steam expertise and application outsourced? (Steam equipment suppliers are responsible for steam supply, operation and maintenance)
    d. Is steam expertise 'hired' via energy auditors or consultants?
    e. Are there other means used by enterprises to maintain a proper level of steam expertise?
3. Can you indicate specific steam experts (persons) in your country? Please specify using the **C. Template for Steam Experts. Project Deliverable (2.3)**

<u>Key players in Industrial Steam (Force Field Analysis)</u>

1. Who are the key players in the field of steam use, technology (transfer) and expertise?
    a. Industrial enterprises
    b. Equipment suppliers
    c. Technology suppliers
    d. Contractors
    e. Consultants
    f. Energy auditors
    g. Sector organisations
    h. Expert platforms
    i. Other
2. What is there role in the field of Industrial Steam?
3. What are their interests in the field of Industrial Steam?
4. Which role do they have/take in stimulating efficient use of industrial steam?

<u>Energy Auditing Practises</u>

1. Are enterprises regularly audited on energy use and efficiency?
2. What are the main reasons for an enterprise to do an energy audit?
    a. Legal obligations
    b. Subsidised by government
    c. To be able to cut energy costs
    d. As part of their energy management system
    e. As part of their sustainability policy
    f. Other
3. Is there a national legal or regulatory framework to stimulate the rationale use of energy and how are energy audits part of this? Please specify (name, main obligations, enforcement and checking (audits)?
4. Are there, apart from the EED obligations, national or local, obligations for enterprises to perform energy audits?
5. What type of organizations have the obligations to perform energy audits? (SME's, non-SME's, based on energy use (> x PJ), other)

6. How are enterprises, without the legal obligations to perform an audit, stimulated to perform audits? (see EED Article 8)
7. Are there any support programmes from national or local government to stimulate the rational use of energy, including the execution of audits?
8. Are audit reports registered from governmental side or others?
9. How are audit results being followed up (implementation guiding, monitoring)?
10. Based on the above can you give figures (or an indication) on the implementation rate of identified energy efficiency measures from the audits? Please comment on the (high or low level of implementations: what are the main arguments for success or failure).
11. What is currently hindering the implementation of steam/energy saving measures? Please argument (with facts) and explain.
12. Are there any financial instruments and or programmes from national and/or local governments to support he rational use of energy and/or steam (subsidies, fiscal and financial instruments, bank guarantees, revolving funds, green loans,…)
13. Can you indicate specific energy auditing tools, practises and or methodologies? Please specify using the **A. Template for Tools and Methodologies.**
14. Can you indicate specific information (guide books, websites, factsheets, trainings…) on energy auditing? Please specify using the **B. Template for Information Sources and Training Materials.**

<u>Management Practises</u>

1. What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?
2. Can you indicate the amount of certifications issued on the above mentioned standards?
3. Are there any other management practises or standards where energy efficiency is addressed or that could accommodate energy efficiency policies in enterprises?
4. What financial (risk) assessment tools and methods are generally used in industrial enterprises in your countries to assess investments?
    a. NPV (Net Present Value)
    b. IRR (Internal Rate of Return)
    c. LCC (Life Cycle Costing)
    d. TCO (Total Cost of Ownership)
    e. SPP (Single Payback Period)
    f. Other
5. How do they influence (negatively or positively) the investment decisions for energy efficiency projects)? Please explain.
6. Are you aware of any other (innovative) business models, management practises or financial assessment practises that could accommodate energy efficiency policies in enterprises? Please specify.

<u>Non Energy Benefits</u>

1. How are non-energy benefits accounted for when making investment decisions?
2. Do you have any good practises available in your country how the inclusion of non-energy benefits in the assessment influenced the investment decision for energy efficiency investments?

Behaviour and energy efficiency

1. Do you have examples from your country on studies, pilots, programmes or practises where insights from behavioural science and change management were used to enhance energy efficiency in enterprises? Please specify (publication, report, language,…)
2. Can you describe the striking successes and/or failures of these approaches?

A.2 Questionnaire Enterprises: Good Practises and Critical Success Factors

QUESTIONS

Identification of Critical Success Factors

1. What is the story, what is the success?
2. What specific measures are being taken?
    a. Steam production
    b. Steam distribution
    c. Steam use (incl. heat exchange(rs))
3. What is the type of measure:
    a. Technical (new equipment, new technology)
    b. Good housekeeping (controls, maintenance, settings (P,T,conductivity,..))
    c. Organisational
    d. Logistics
    e. Other
4. What is the amount of energy saved (% of total energy for steam production, MJ)?
5. What is the amount of EURO'S saved?
6. What are the (proven or probable) additional benefits of the measures taken?
    a. Work environment, health and safety
    b. Environmental
    c. Productivity (throughput)
    d. Quality
    e. Maintenance
    f. Other (see figure below for inspiration)

Main category	Sub categories
Productivity (cost per unit)	Consumption of materials Necessary work force Product quality Unscheduled down-time Other
Sales	Sustainability Customer satisfaction/loyalty Publicity Unique selling points (such as sustainability) Other
Work environment / health /safety	Draft Air/dust/vapors Sound/noise Light Employee flux/retention Room temperature Safety Stress Heavy lifts Other
External environment and resources	Waste and waste water (incl. industrial waste, hazardous waste, heat, materials) CO_2 emissions Other GHG emissions Other emissions Security of supply / self sufficiency Other

7. Can these benefits be quantified? (Euro's, increase in productivity, decrease of stand still hours,…)
8. What (which activity, condition, support,…) was **essential** (without this it would never have happened) in achieving the specific success in steam efficiency improvement (**Critical Success Factor**)? For example:
    a. Internal:
        i. Management (support, resources (time, money,..), energy management system, dedicated tasks,…)
        ii. Image (enterprise wants to be sustainable,…)
        iii. Assessment of investment (LCC, include NEB's,…)
        iv. Organisational (dedicated multidisciplinary energy team, energy efficiency in line organisation instead of staff)
        v. Training (on steam use or energy efficiency)
        vi. Monitoring and/or checking of (energy use)
        vii. …
    b. External:
        i. Available fiscal and/or financial instruments and support
        ii. Support from consultant, supplier, government
        iii. Legislation and/or regulation
        iv. …
9. Please specify how the (combination of this) factor(s) finally led to a better steam efficiency? Try to describe the chain of "cause and effect". E.g. "Since we are having an energy management system, I have specific tasks and responsibilities on energy efficiency. I have time and resources allocated and in my yearly evaluation energy efficiency is one of the evaluated items…"

10. Is/was your organisation aware of this CSF’s?
    a. If yes, how is continual attention for this CSF’s being organised within your organisation?
    b. If no, what would be needed to guarantee structural attention for these CSF’s?
11. In what way do these CSF’s conflict with the business objectives of the organisation?

Steam Up project

1. Would you be interested to be informed on the Steam Up project and its progress?
2. Would you be interested to be informed on the Steam Up training courses and or networking seminars?
3. Would you be interested to be a pilot enterprise for the in-depth steam and energy efficiency audits that will be developed in the course of the project?

A.3 Questionnaire Enterprises: Guidelines for Interviews on Steam, Energy Audits and Management Practises

QUESTIONS

Steam use in general (Why is it used?)

1. For what purpose(s) is steam being used?
2. Have alternatives for steam being assessed?
3. Does the supplied steam quality (temperature, pressure) meet the demanded steam quality?

Steam use an operation

1. Do you know the efficiency of your steam boiler?
2. How much fuel is used for steam production and what type (gas, oil, biomass, other)?
3. What is the operation pressure of the steam boiler and how does it relate to the required steam pressure (or temperature) in the process?
4. Does your steam boiler have a good insulation in its envelope?
    a. Is there a national standard for steam boiler insulation and is that followed?
    b. If no standard, do you know what the insulation thickness is?
5. What are the conductivity settings for your boiler water? Why at that specific level?
6. Is the installation turned off when there is no steam demand (during stand still, overnight and/or in the weekend)?
7. Does the distribution system meet the optimum criteria and what is the basis for this criteria (standard, guidelines,…)?
8. What kind of energy saving measures are already taken to improve steam efficiency and are there any other measures you can think of?
    a. Economizer
    b. Optimizing blow down control
    c. Condensate return
    d. Air pre heating
    e. Shut down during stand still (overnight, weekend and/or when there is no steam demand)
    f. Pressure reduction (when no steam demand)
    g. Other
9. How often are steam traps checked and what criteria is used for starting a check? Are steam traps regularly checked?

Energy use, energy costs and potentials for savings

1. What is the total energy use for steam production in your enterprise?
2. Are there EPI’s for steam defined?
3. How does this relate to the overall energy use for production in your enterprises?
4. What are the total costs for steam production annually?
5. What are the total costs for inspection, maintenance and operation annually?

6. Do you think this operation costs can be decreased?
    a. If no, why not?
    b. If yes, can you estimate how many savings (%) can be made?
7. Do you have information on energy savings options for your steam system?
    a. If yes, what is your source?
        i. Website(s)
        ii. Energy consultants
        iii. Former audits
        iv. Sector organisation
        v. Energy efficiency programmes (national, local government, energy agency)
        vi. Supplier information / consultancy
    b. If no, who would you turn to get this information?
8. Are there already any energy saving measures taken:
    a. If no, why not (What is hindering this?)
    b. If yes, what kind of measures are already taken?
9. Is the energy saving of this measure verified (on a regular basis)?
    a. If yes, how?
    b. If no, why not?
10. Are there any energy saving measures analysed and rejected by your organisation?
    a. If yes, explain why?
11. What saving measures (still) can be taken in your organization?
    a. Heat recovery (exhaust, blowdown, condensate return)
    b. Operation (operation pressure, stand still, idle mode (no demand))
    c. Control (automated blow down, exhaust oxygen,…)
    d. Distribution (steam traps, control and design of heat exchangers,…)
    e. …
12. Do you know how many energy/money can be saved by taken this measure?
13. If yes, does your management know how many energy/money can be saved by taking this measure?
    a. If yes (and considering that the measure is economical viable), why is the measure still not taken?
    b. If no, why not?

<u>Check and audits</u>

1. Is/are the steam boiler(s) checked on a regular basis and if yes on what frequencies?
2. Is the distribution system checked on a regular basis and if ye on what frequencies?
3. If a regular check is being performed what is being checked on?
    a. Emission numbers (O_2, $NO_{x,\ldots)}$
    b. Boiler water quality and composition
    c. Integrity of pressure equipment
    d. Energy saving opportunities
    e. Steam traps
    f. …

4. Who is doing the steam system checks:
    a. Internal expert
    b. External (checking authority)
    c. Other

Key players in in your organisation for steam and energy efficiency

1. Which people in your organization have an (direct or indirect) influence on energy use and energy efficiency?
    a. What kind of influence do these people have?
    b. How are the people made aware of this influence (training,…)?
2. How are they involved in improving energy efficiency in your organization?
    a. Is top management involved?
        i. If yes, how?
        ii. If not, explain why?
3. What are their roles, tasks, responsibilities and authorities in relation to energy and energy efficiency?
4. How is the fulfilment of these roles, tasks and responsibilities checked on a regularly basis?

Energy Auditing Practises

1. Are energy audits regularly executed at your enterprise?
2. What are the main reasons for your enterprise to do an energy audit?
    a. Legal obligations
    b. Subsidised by government
    c. To be able to cut energy costs
    d. As part of their energy management system
    e. As part of their sustainability policy
    f. As a requirement from customers and/or suppliers
    g. Other
3. Which people in your organization are involved in the auditing process and which relevant education do they have?
4. Why specifically those people?
5. Is (top) management involved?
    a. If yes, how?
    b. If not, explain why?
6. Which people have an influence (or are making decisions) on the implementation of energy saving measures?
7. Are they involved in (part) of the auditing process?
    a. If yes, how?
    b. If not, explain why?
8. How are audit results being followed up in your organisation (implementation guiding, monitoring) by:
    a. Internal: e.g. energy manager, steam/energy responsible, maintenance department,…
    b. External: The auditor
    c. Your management and/or in process as defined in the Energy Management System

9. Is a plan made for the implementation of the identified measures?
10. Are resources (time, capacity, money) allocated for the implementation?
11. How is the (economic) viability of the identified measures being assessed?
    a. SPP
    b. IRR
    c. NPV
    d. LCC
    e. TCO
    f. …
12. Are non-energy benefits accounted for when making the investment decisions?
    a. If yes, how are they accounted for?
    b. If no, explain why?

<u>Management Practises (questions to identify awareness for a.o. (top) management))</u>

1. What is the total energy use for steam production in your enterprise?
2. How does this relate to the overall energy use for production in your enterprises?
3. What are the total costs for steam production annually?
4. Do you think this can be decreased?
    a. If no, why not?
    b. If yes, can you estimate how many savings (%) can be made?
5. Is it a management priority to decrease energy use and/or cost?
    a. If yes, why is this important to your organization?
    b. If no, explain why?
6. What would be needed for your organization to realise this decrease in energy use and/or cost?
7. How could this be organized?
8. Does your organization have in place a management system like ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…?
9. Is this system certified?
10. Is energy in one way or another addressed (or integrated) in one of these systems? (Note that requirements for ISO 50001 can easily be integrated into ISO 9001, ISO 14001 and ISO 22000)
11. What financial (risk) assessment tools and methods are used in your enterprise to assess investments?
    a. NPV (Net Present Value)
    b. IRR (Internal Rate of Return)
    c. LCC (Life Cycle Costing)
    d. TCO (Total Cost of Ownership)
    e. SPP (Single Payback Period)
    f. Other
12. Are energy efficiency investments assessed in the same way as ‘regular’ investments?
13. Are non-energy benefits accounted for when making the investment decisions?
    a. If yes, how are they accounted for?
    b. If no, explain why?

Inventory initial Bench Marking Data

1. Efficiency of steam boiler [%]
2. Kind of fuel [gas, oil, biomass]
3. Nominal steam capacity [tons/hour]
4. Size of boiler [MWth]
5. Boiler Pressure level [barg] (pressure referred to atmosphere (1 bar absolute)
6. Boiler's operation [hours/year]
7. Kind of control (CO/O2)
8. Exhaust Gas Temperature [°C] after Economizers (if existing), Economizer yes/no
9. O_2 Level in exhaust gas in [%]
10. Steam production efficiency [GJ/kg produced steam], [GJ/GJ], as this is not available in some cases: (esp. fresh water, which is metered, is not directly related to steam production, depending on condensate return rate)
    a. [m^3 gas/m^3 feed in water] / Temperature of feed in water
    b. [m^3 gas/kg fresh water for steam]
11. Overall steam use efficiency [kg steam/ per product (piece, kg, m^2)] or (if not available) [m^3 gas for steam boiler / per product(piece, kg, m^2)]
12. Rate of condensate return [%] (at which Temperature [°C])
13. Rate of direct used steam [%]
14. Leakage detection at steam traps: yes/no (how often per year)

Steam Up project

1. Would you be interested to be informed on the Steam Up project and its progress?
2. Would you be interested to be informed on the Steam Up training courses and or networking seminars?
3. Would you be interested to be a pilot enterprise for the in-depth steam and energy efficiency audits that will be developed in the course of the project?

A. 4 Questionnaire for Energy Auditor

General Information

Name:			
Organisation:			
Country:		Region:	
Years of Experience:			
Numbers of audits (annually):		Last audit (date):	
Certification or Registration:		Year	
Membership Association for Energy or Environmental Auditors;			
Contacts			
E-mail:		Telephone:	
Notified:			

QUESTIONS

General information

1. In what type of enterprises do you work in general?
    a. SME's
        i. 10-50 employees
        ii. 50-100 employees
        iii. 100-250 employees
    b. Non-SME's
    c. Energy intensive enterprises
    d. Non-energy intensive enterprises
2. In what type of sectors do you work?
    a. Chemical
    b. Oil and Gas Processing
    c. Paper and Pulp
    d. Food processing
        i. Dairy
        ii. Vegetables and fruit
        iii. Meat
        iv. Breweries / soft drinks
    e. Textile production
    f. Metallurgic
    g. Cement and building materials
    h. …

Energy audit Method and Process

1. Who is your main client in the enterprise (Who give the order to do an energy audit)?
    a. Higher management
    b. Energy manager
    c. Energy representative
    d. Other
2. What are the main reasons for an enterprise to do an energy audit?
    a. Legal obligations
    b. Subsidised by government
    c. To be able to cut energy costs
    d. As part of their energy management system
    e. As part of their sustainability policy
3. Which people of the enterprise are generally involved in the audit process?
    a. Higher management
    b. Energy manager
    c. Production manager
    d. Procurement
    e. Technical services (maintenance)
    f. Process Engineers

g. Sustainability manager
h. Other

Audit on Steam System

1. How many of your audits include steam systems? (% of total)
2. When a steam system is present in the enterprises, is the steam systems always part of the audit?
    a. If no, please explain
    b. If yes, please specify which parts:
        i. Steam production (steam boiler)
        ii. Steam distribution (transport from and to production)
        iii. Steam use (in production)
3. When specific parts as described above are not audited, please explain why?
4. In the audits that you did on steam systems, what kind of energy saving measures on the steam system are generally already been taken?
5. In the audits that you did on steam systems, what kind of energy saving measures on the steam system are generally **not** already been taken? What is hindering the implementation of these measures?
6. Which steam saving measures do you generally recommend? (please mention 3)
7. What where your latest three recommended steam saving measures?
8. Where they economically feasible for the enterprise (SPP < 2 years)?
9. Where they actually implemented?

Audit results and reporting

1. What is the result of your audit?
    a. List of energy efficiency measures (incl. financial assessment)
    b. a. plus a plan for implementation (time, resources, risks assessment,…)
    c. b. plus a monitoring plan to verify energy and other savings
    d. Other
2. How do you report the audit findings to the enterprise?
    a. Report?
    b. Presentation for energy representative?
    c. Presentation for energy manager?
    d. Presentation for (higher) management?
    e. Combination of above?
3. How do you (economically) asses the identified energy saving measures?
    a. Based on SPP
    b. Based on IRR
    c. Based on NPV
    d. Based on TCO
    e. Based on LCC
    f. Other

4. Apart from energy cost savings, are there other cost saving potentials addressed by the measures you propose?
    a. If no, why not?
    b. If yes, what is the influence on actual (chance) for implementation? Please give an example.
    c. On a scale from 1 to 10, how significant are these savings in relation to the energy cost savings?

Monitoring and Follow Up of Audits

1. What are the main challenges/problems you encounter in following up the audits in order to 'check' implementation of the identified measures?
2. When following up, which percentage of the economical viable measures (SPP < 2 year) are being taken after 1 year?
3. When measures are not being taken do you get to know why?
4. If measures are not being taken what are the reasons communicated to you for this?
    a. Lack of resources (time, capacity, money)?
    b. Proposals for investment where not accepted by management, production or others?
    c. Other?
5. What methods do you use in your audits to facilitate enterprises (energy representative) in getting measures implemented?
6. What is in your opinion needed to enhance the implementation rate of identified energy saving measures form energy audits?

Steam Up project

1. Would you be interested to be informed on the Steam Up project and its progress?
2. Would you be interested to be informed on the Steam Up training courses and or networking seminars?

4.

5. Appendix B: Country reports

B.1 AUSTRIA

Industrial enterprises

Regarding to Statistik Austria in 2010 a total of 308,735 companies exist in Austria; 1,068 of them are non SMEs. But for the energy efficiency directive it is expected that more companies will be big companies, as some SME-companies will be counted as big company (because of ownership-structure).

The total energy consumption in Austria for 2014 is 1,119,241 TJ. The consumption for industry in 2014 was 335,863 TJ from which 26% (87,414 TJ) is used for steam within the industrial energy consumption.

Sector	Final energy consumption in 2014 in TJ
Steel	**51.102**
Chemistry	**42.676**
Non iron metals	8.214
Stone, glass	**36.645**
Automotive	5.502
Machine building	26.841
Mining	6.409
Food	23.735
Pulp and Paper	**71.226**
Wood	**28.631**
Construction	20.398
Textile	3.738
Others	10.566

Table: Overview on energy consumption of the different sectors, AEA, Source for data, Nutzenergieanalyse, 2013, statistic Austria

The main industrial sectors from an energetic point of view in Austria are:

Steel: Steel industry is one of the sectors with the biggest energy consumption in Austria. There are only a few plants, with one steel production company being outstanding for its size. The other companies are mainly machining the steel. As this sector has no significant steam demand it is not relevant.

Pulp and Paper is the main steam producing and consuming sector in Austria. In Austria this sector is very strong and has around 20 big pulp paper plants.

Chemistry: This sector is more heterogenic with different big industrial plants producing different products (e.g. pharmaceutical sector, plastic production, gloves and fibre production, …)

Wood Production: The wood production has a long tradition in Austria, quite a few very big companies dominate the market but also several medium and a lot of small plants exist.

Food Industry: Within this sector a lot of different sub-sectors exist in Austria, e.g. brewery and dairies being very important ones. Almost all of these subsectors (e.g. meat, bakery) use steam.

Sector	**Share of Steam for Final Energy Consumption**	**Share of Gas on Steam Production**	**Share of Biogen on Steam Prod.**
Paper industry	66 %	44 %	48 %
Wood industry	38 %	6 %	86 %
Chemistry	32 %	33 %	21 %
Food industry	38 %	80 %	2 %
Textile	28 %	92 %	0 %
Mining	28 %	100 %	0 %

Source: AEA, Source for data, Nutzenergieanalyse, 2013, statistic Austria

<u>Installations</u>

In Austria the Ministry of Economics publishes annual data on pressurized equipment, esp. type and number of steam boiler that are monitored by Austrian law for the pressurized equipment regulation:

A total of 2.886 steam boilers (incl. heat recovery boilers) are obliged by this law, with 1.431 fire tube smoke boilers having the biggest share, 477 water tube boilers, 105 high speed steam raising boilers, 467 electric steam boilers and 332 others. In addition 74 heat recovery boilers are in use.

There is no information on the distribution of the installed power but for the heating area:

- In the area below 50 m² heating area 1.616 steam boilers are installed: From that 679 fire tube smoke boilers and 464 electric steam boilers have the biggest shares.
- The second most important group are boilers between 50 and 400 m²: 865 boilers are installed, with fire tube smoke boilers (664) being the group with most boilers installed.
- In the group with the highest power (above 1200 m² with 165 boilers) almost only water tube boilers (115) are installed.

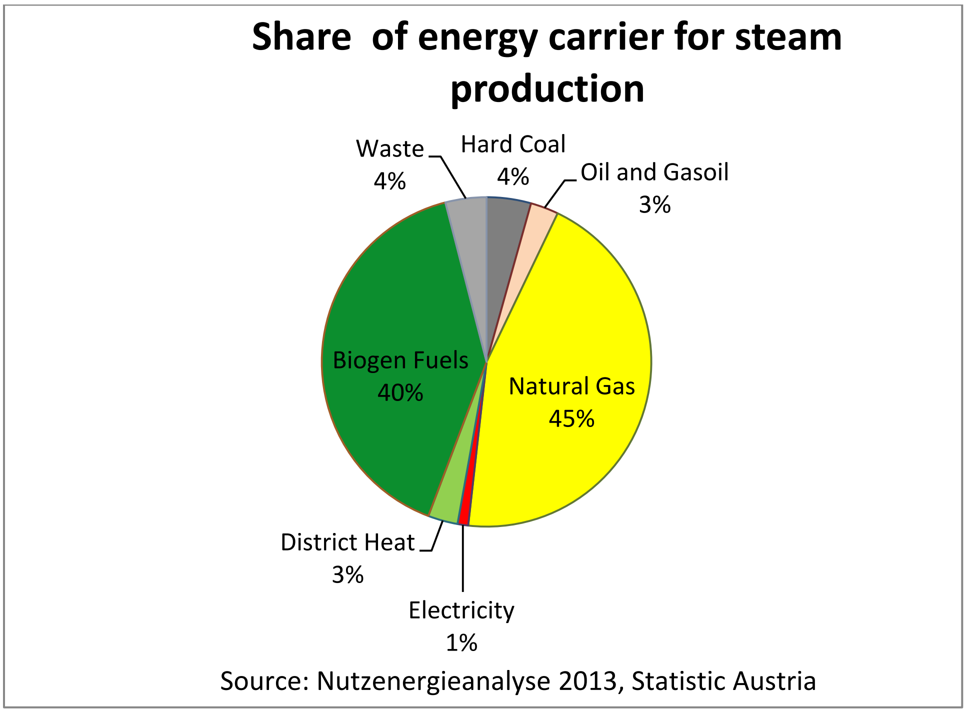
It is estimated that a total of 5.000 steam boilers (incl. boilers that do not fall under the pressurized equipment regulation) are installed.

From a not-published boiler database with around 500 boilers which is collected for the purpose of air emissions (for boilers above a certain power, depending on the fuel), the average power is 56 MWth. This database includes power stations. The average running time is around 4,000 h.

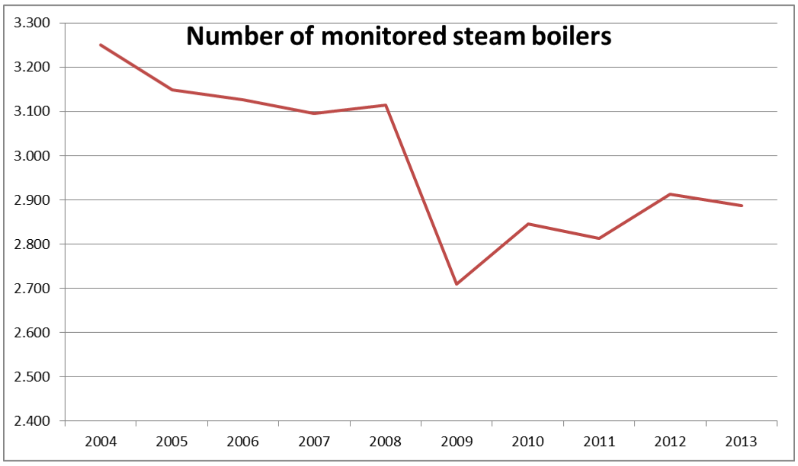
The exhaust temperature (when installed!) was 187°C.

From that 500 boilers around the half (230) were installed before 1987 (which would mean an age of 25 years).

For steam purposes the main energy carriers used in Austria are natural gas and biomass.



<u>Sales figures and developing trends</u>



The number of monitored steam boilers in Austria is shrinking over the last 10 years but from 2010 on it is quite stable. During the economic crisis 2008/2009 the number of steam boilers was decreasing very much. The number of newly installed boilers in Austria is not known. (at least currently to AEA)

Energy use and potential

From the 1,080 PJ energetic end consumption in 2014, 320 PJ were used by industry. (statistic Austria energy balance 2014).

In 2012: The total end (final) consumption was 1.119 PJ (Austria), 335.683 TJ was the consumption for industry, for steam 87.414 TJ (26%).

The Austrian Energy Agency (project leader Konstantin Kulterer) produced a study on the energy saving potential in the steam production (not in steam use!) in Austria. Main results were that a saving potential of 6.6% of the total fuel consumption could be realized (enconcomic feasible).

The main savings can be achieved by the following saving measures:

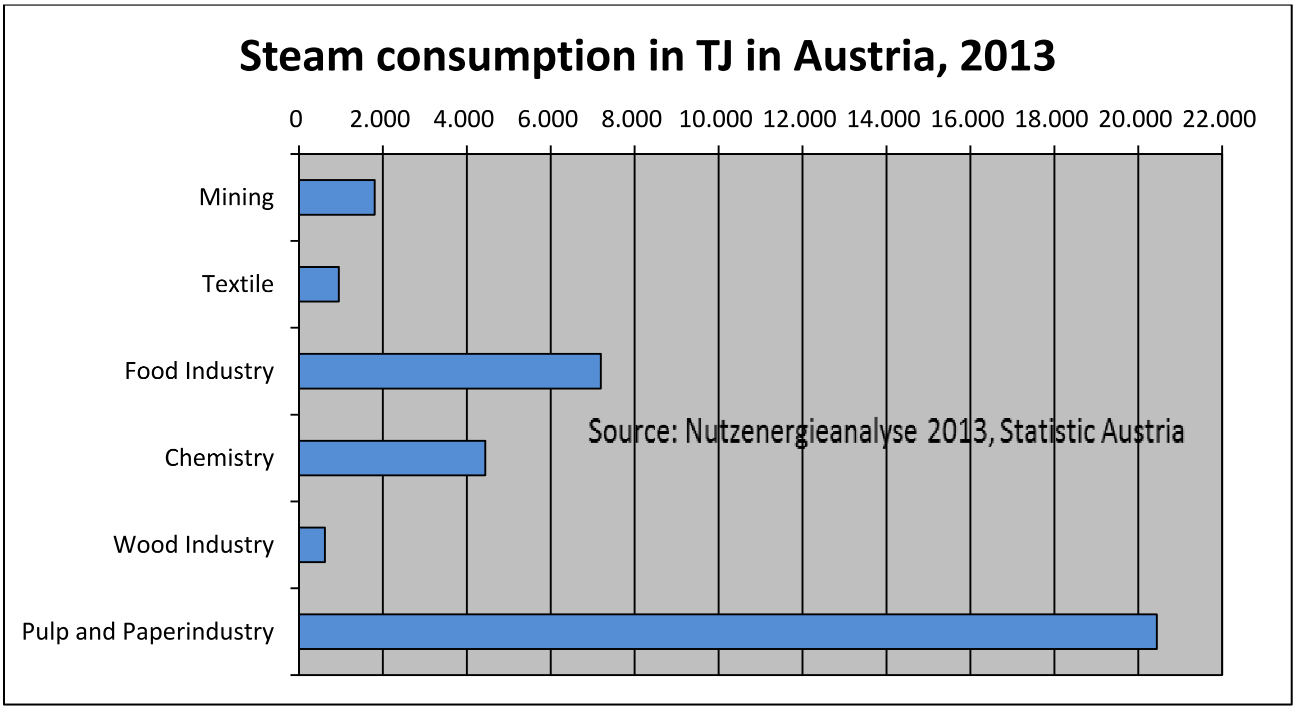
Economizer, air-pre-heating, CO2 and O2 control strategy, boiler blow down (3-8% savings possible).

The main methodologies for this study was the in der Datenbank zur Emissionserklärung (EMD) for 500 plants and expert workshops from the steam industry.

The sectors were not directly analysed, but which sectors are relevant is seen in the next section.

Sectors and processes (main industrial users)

But in the graph below the main sectors relevant for steam use in Austria are paper, food and chemistry industry.



For which end using processes steam is used is not analysed, steam is an end-use category for itself.

Austrian Economic Chambers

In Austria every single person who is entitled to operate an independent business venture in crafts and trades, industry, mining, finance, banking and insurance, transport, information and communication, broadcasting, tourism and leisure, as well as other services, is a member of the Federal Economic Chamber under Austrian law (Economic Chamber Act 1998). The Austrian Economic Chambers represent more than 450,000 member companies.

At the same time every member is also a **member of multiple Economic Chamber organisations**. In this way every member belongs to the Regional Chamber of his/her federal province and the relevant Trade Group, as well as the Austrian Federal Economic Chamber and the relevant Trade Association (https://www.wko.at/Content.Node/wir/Austrian_Economic_Chambers_Home.html).

The sector industry is a Trade Group within the Chamber of Commerce and divided into sub-sectors: e.g. chemical industry, steel and mining, pulp and paper, agro-food and beverage industry, oil industry, textile industry.

The Economic Chambers is a service providers and offers expert advice on topics from labour laws to customs information. The Austrian Economic Chamber is also committed to implementing forward-looking policies that benefit the economy, such as tax relief, cutting red tape, and subsidies. The Austrian Economic Chamber has also educational facilities to improve the competitive ability of domestic companies.

The Economic Chambers offers expert advice also on relevant topics for energy efficiency. Relevant topics are published on the Website (only on German):

https://www.wko.at/Content.Node/Service/Umwelt-und-Energie/Energie-und-Klima/Energieeffizienz/Energieeffizienz---Themenstartseite.html

The Economic Chamber as project partner of the "European Energy Manager (EUREM)" training program is running the EUREM training in Austria. The EUREM is an EU-wide learning and knowledge platform focussed on the needs of energy managers in industries. The topic „steam“ is also part of the training.

The Economic Chamber is also publishing 5 times a year the journal “Umweltschutz der Wirtschaft”, where also energy relevant topics were published.

https://webshop.wko.at/index.php?idp=59&idpm=3525&idpd=5019

Federation of Austrian Industries

The Federation of Austrian Industries, currently comprising about 4,200 members, is a voluntary body representing the interests of Austrian industry (http://www.iv-net.at/b1373m114/the-federation-of-austrian-industries-iv/). Most of the large industries in Austria are members of this Federation on a voluntary basis. The Federation of Austrian Industries runs also nine independent Regional Groups in each Austrian province.

As a lobbying organisation, the Federation of Austrian Industries has set itself the goal of representing the interests of its members both in Austria and at the European level in a targeted and sustainable manner, thus strengthening Austria and Europe as a location for business and industry.

Legislation and regulation (steam and energy efficiency)

a) Requirements for pressure equipment

Boiler Law (BGBl. 211/1992, as amended on the 1ts of July 2015) ordinances: general requirements also for steam boilers and clustering of the steam boiler

Ordinance to the Boiler Law regarding pressure equipment: EU declaration of conformity of pressure equipment to harmonised standards

Ordinance to the Boiler Law regarding installation and operation on steam boilers:

(1) Operation of steam boilers without permanent control (excluding hot water boilers)
(2) Operation of hot water boilers without permanent control
(3) Operation of steam boilers (excluding hot water boilers) with reduced operation pressure (max. 1 bar) for a defined period of time without permanent control
(4) Operation of hot water boilers with reduced operation temperature (less than 120°C) for a defined period of time without permanent control
(5) Operation of steam and hot water boilers with remote control
(6) Requirements for the saline ferrous steam an feed water regrading eg pH, conductivity, O_2, CO_2.

Ordinance to the Boiler Law regarding automatic operation control (BGBl. II Nr. 147/2012)

Ordinances to the Boiler Law regarding control of pressure equipment: the inspections

have to be carried out by accredited inspection institute, e.g.:

(1) First operational inspection of steam boilers
(2) Operational inspection of steam boilers in case of replacement or after standstills with more than 1 year.
(3) Periodically inspection (inspection intervals) for steam boilers (internal inspection, external inspection, inspection of the pressure) in dependence of their inspection level between 1 and 12 years.

Periodically inspection for steam boilers regarding inspection level 2

For steam boilers		Inspection interval
	for external inspection	**1 year**
	for internal inspection	**3 years**
	inspection of the pressure	**9 years**

For piping system		**3 years**

Periodically inspection for steam boilers regarding inspection level 3

For steam boilers		Inspection interval
	for the first external inspection	**1 year**
	Further external inspections	**2 – 5 years**
	for the first internal inspection	**1 year**
	Further internal inspections	**1 – 5 years**
	1st time inspection of the pressure	**2 years**
	Further inspections of the pressure	**2 – 10 years**
For piping system		**2 – 6 years**

Periodically inspection for steam boilers regarding inspection level 4

For steam boilers		Inspection interval
	for external inspection	**2 years**
	for internal inspection	**6 years**
	inspection of the pressure	**12 years**
For piping system		**6 years**

Ordinances to the Boiler Law regarding the requirements for maintenance of steam boilers and boiler attendants: qualification criteria for boiler attendants, definition of roles and responsibilities of boiler attendants

b) Requirements for air pollution control and environmental requirements

- Ordinance to the Industrial Code regarding emission limit value for firing systems with an installed thermal capacity from 50kW up to 50MW; periodic monitoring is required in dependence of the energy source.
- Emission Control Law for steam boilers (BGBl. 150/2004): emission limit values for steam systems with an installed thermal capacity of 50MW or more; periodic monitoring is required in dependence of the energy source.
- Ordinance to the Emission Control Law for steam boilers: annually emission declaration must be sent by each obliged company to the Environmental Agency.

- Air Pollution Control Law for boiler installations and ordinance to this law (BGBl. 19/1989): emission limit values

c) Requirements for occupational health & safety regulations:

- Occupational Health and Safety Law
- Ordinance to the Occupational Health and Safety Law regarding workplaces
- Ordinance to the Occupational Health and Safety Law regarding work equipment
- Ordinance to the Occupational Health and Safety Law regarding machine safety
- Ordinance to the Occupational Health and Safety Law regarding safe operation of gas equipment

d) Requirements for storage of flammable liquids, e.g. fuel oil

e) Requirements of the regional authorities

- Notifications for companies: requirements
- Industrial Code of Austria: periodically check of the notification requirements

On a national level the Industrial Code of Austria requires periodically check of the notifications that apply for each single company.

There are no national standards for steam boiler operation and design; on international level a preparatory study on steam boilers is already existing according to the EU Ecodesign Directive.

Ecodesign Preparatory Study on Steam Boilers (ENTR Lot 7):

The Ecodesign Directive (Directive 2009/125/EC) establishes a framework for the setting of Community Ecodesign requirements for energy-related products with the aim of ensuring the free movement of such products within the internal market. This preparatory study is carried out in the framework of this Directive. Its aim is to provide the European Commission with a technical, environmental and economic analysis of steam boilers according to Article 15 of the Ecodesign Directive. This preparatory study deals with boilers based on water for steam generation.

Support scheme and programmes of the Austrian provinces

The aim of this support schemes and programmes are subsidies for energy audits; this could be also an audit focused on the steam system.

klimaaktiv trainings of energy auditors

The 9 day klimaaktiv trainings of energy auditors in industry (SME and industry) also includes a 1-day training for steam systems. The training is financially supported by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, the training fee which has to be paid by the participants is reduced.

Environmental and Water Management Fund (UWF)

The Environmental and Water Management Fund (UWF) is managed by the Kommunalkredit Public Consulting (KPC) on behalf of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. Within this Fund also energy efficient measures are financially supported; investment costs are partially refunded. Regarding steam, measures in the distribution network are financially supported. Optimization measures regarding implementation of e.g. economizer, control system and heat recovery are not supported by this Fund.

Austrian Climate and Energy Funds

The Climate and Energy Fund was set up by the Austrian government in 2007 with the aim to develop new, innovative methods of climate protection and introduce a sustainable energy policy. It funds climate protection and energy projects with a research, mobility and market penetration focus. Sustainability and efficiency are the cornerstones of all of its measures.

Check and audits

See chapter “legislation and regulation” for regular checks. Some companies also perform annual checks on the functionality of the steam system and e.g. annual checks on steam traps.

Checks are performed on:

a. Emission numbers (O_2, NO_x,…)
b. Boiler water quality and composition
c. Integrity of pressure equipment

The following auditing tools were developed in Austria.

- Energy Audit Guideline for Steam Systems from the Austrian Energy Agency within the klimaaktiv programme energy efficient companies.
- Energy Audit Report for Steam Systems, Austrian Energy Agency within the klimaaktiv programme energy efficient companies..
- Trainings material on steam systems for the trainings of the Austrian Energy Agency within the klimaaktiv programme energy efficient companies.

The following Guide Books are very useful:

UNIDO: Industrial Steam System Optimization (SSO) Experts Training, Training Manual, 2012

Carbon Trust (2003): ECG066, Energy Consumption Guide, Steam Generation Costs 2003 (Update), Actionenergy from Carbon Trust

Carbon Trust (2004) ECG092, Energy Consumption Guide, Steam Distribution Costs, 2004 (Update), Actionenergy from Carbon Trust

Europäische Kommission (2009): Reference Documents on Best Available Techniques on Energy Efficiency

Harrel, Greg (2002): Steam System Survey Guide, Oak Ridge National Laboratory, for the U.S. Department of Energy BestPractices Steam Program

Sattler, P., Fuchsberger, K., Hinterndorfer, M,: Einsparpotentiale in der industriellen Dampferzeugung und –anwendung im Auftrag des Landesenergieverein Steiermark, 2009

Spirax Sarco (2006): Grundlagen der Dampf- und Kondensattechnologie, Konstanz

Spirax Sarco (2007). Leitfaden für die Gestaltung von Dampf- und Kondensatnetzen, die Auswahl und den Einbau von Kondensatableitern, die Fehlersuche in Dampf- und Kondensatnetzen, den Betrieb von Dampf- und Kondensatanlagen, Konstanz

University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 2, Boilers and Furnaces, The Energy Research Institute

University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 5, Steam Systems, The Energy Research Institute

University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 6, Insulation, The Energy Research Institute

Steam Experts and Expertise

There is the general chamber of commerce department: Vereinigung Österr. Kessellieferanten (Association for Austrian boiler supplier) who is also interested in energy efficiency topics, in addition the association of gas- and heat supplying companies (Fachverband der Gas- und Wärmeversorgungsunternehmungen) is interested in energy efficiency (esp. now for the energy efficiency law).

The following trainings are organized on a regular basis in Austria:

- Klimaaktiv one-day training on steam systems, klimaaktiv energy efficient companies
- Bosch: 2 day seminar on steam boilers: innovative boiler technology, modernization, Optimization
- Spirax Sarco: In-house trainings
- Courses, where steam is a topic: EUREM, other energy efficiency trainings (esp. for energy attendants)

The knowledge on steam is very different in Austria. Mainly it is depending on the personal know-how of the different personal responsible for steam and/or energy. No company has dedicated steam experts, but some of the technicians responsible for one or more plants with a high share of steam production cost on total cost (or high share of energy consumption for steam) have a good knowledge. Esp. steam traps are checked by external companies, also flue gas measurements are done externally.

Steam Experts are for example:

Bosch Industry (Heinz Rieder), Econgas (Ing. Peter Haiböck), Astebo (Andreas Korn), Gestra (Klackl), Spirax Sarco (Michael Schirmer), Helmut Frint (SAAKE)

Key players in Industrial Steam (Force Field Analysis)

Equipment supplier have generally the interest to sell new equipment.

In Austria the companies: Bosch Austria, Viessmann, Astebo are the main steam boiler producing companies. They consult companies in the topic higher efficiency for boiler houses during their site visits.

SAAKE GesmbH is a burner equipment producer: This company supplies companies with information on high efficient burners.

Spirax Sarco, Gestra Flowserve (Eichler Flowserve), TVL are technology suppliers for steam distribution equipment and heat recovery equipment in steam systems. They consult companies in e.g. steam distribution audits (esp. steam traps-check).

Econgas, authorized expert on §34 Abs. 4 Emissionsregulation for boilers: during emission metering he also calculates efficiency of boilers. Econgas is a company working for an energy provider.

Consultants have mainly the interest of doing an energy audit but also are interest in the implementation of the saving measure, because they do sometimes the detailed engineering or the support for applying for subsidies. They are also interested in implementation as the result of the audit is more relevant.

Some of the consultants in Austria, e.g. Allplan, sattler energy consulting, Weigl Energiedetektiv, UTG are also offering studies on the efficiency of steam boilers.

Some of the Austrian contractors are also dealing with steam systems. Very often they build heating plants, others have steam saving measures as a package in energy saving contracting.

Energy Auditing Practises

Before 2015 there were no legal obligations for energy audits; energy audits were carried out on voluntary basis. With the new Energy Efficiency Law large companies are obliged to carry out energy audits at least every 4 years.

The main reasons for energy audits are:

a. Legal obligations
b. Subsidised by government
c. To be able to cut energy costs
d. As part of their energy management system

Energy Efficiency Law regarding to the EED with obligations large companies, energy suppliers and energy service providers is the main stimulation for rationale use of energy. With the new Energy Efficiency Law large companies are obliged to carry out energy audits at least every 4 years. If a large company implements energy or environmental management system the energy audit can be carried out by an internal qualified expert; otherwise the energy audit must be done by an external qualified auditor.

There are no other obligations besides EED for enterprises to perform energy audits.

Large companies have to perform energy audits in Austria

SMEs are financially supported to perform energy audits. For this there are national and regional subsidy programmes for the execution of energy audits.

Audit reports are not yet registered from governmental side, but with the with the monitoring of the new energy efficiency law energy audits reports will be checked on random sample basis

With the new Energy Efficiency Law there is no obligation for large companies to implement the suggested energy measures; only within an energy- or environmental management system it is guaranteed that energy relevant measures are implemented by setting action plan.

There is no stable basis for the implementation rate of identified energy efficiency measures from the audits.

The following arguments are sometimes used: Too cost intensive, too long pay back periods, missing know-How. But in principle all companies interviewed so far are interested in saving energy in steam systems and are planning to evaluate further saving measures.

Management Practises

The following management systems are used in Austria

- ISO 9001
- ISO 14001
- ISO 50001
- ISO 22000
- OHSAS 18001
- GMP in pharmacy industry
- EMAS Environmental Management and Auditing scheme
- ISO 13485 medical products

- ISO 9001: 4637 valid certificated in 2013 (http://www.iso.org/iso/iso-survey)
- ISO 14001: 1069 valid certificated in 2013 (http://www.iso.org/iso/iso-survey)
- ISO 50001: 67 valid certificated in 2013 (http://www.iso.org/iso/iso-survey)
- ISO 22000: 72 valid certificated in 2013 (http://www.iso.org/iso/iso-survey)
- OHSAS 18001: unknown
- GMP in pharmacy industry: unknown
- EMAS Environmental Management and Auditing scheme: 283 valid certifications 06/2015 (http://www5.umweltbundesamt.at/emas/pz38st.pl)
- ISO 13485 medical products: 238 valid certificated in 2013 (http://www.iso.org/iso/iso-survey)

The following method is used for financial evaluation of investments:

a. SPP (Single Payback Period) (being the most important one)
b. LCC (Life Cycle Costing) (known by a lot of energy managers, and stated to be used in the future…)

In principle very low single payback periods hinder in some companies investments.

In Austria some companies already offer contracting projects, also in the field of steam system efficiency. But this strategy is not very often used.

Non Energy Benefits

Investment decisions are mainly done because of product related issues, e.g. new technologies.

Behaviour and energy efficiency

Examples for projects in Austria are given below:

For example the energy consulting company Sattler Energy Consulting implemented very successful the "Energy Comedy", a satirical show. A complex issue such as energy efficiency is brought with humour as "light fare". It is ~2 hours cabaret for all employees.

Project „Together on the move – energy efficient transport training for migrants" for the target group of migrants: the idea was to create a publication with EE topics which you can use in language courses „indirect way of information".

Project „Topprodukte" EE training for retailers.
Austria took part at the EU project „Behave"; this project was focused on the behaviour households, not industry:

- The project „Behave" assessed existing awareness raising campaigns
- The result was that the most successful key factor is target group segmentation
- That means that different needs of people must be considered
- It needs different marketing approaches for different needs; not for households with low income, they need financial support

Project of AEA: Are Lifestyles useful for target group segmentation? This project was focused on the behaviour households, not industry:

- Survey in 100 households in Vienna (basis data)
- Result: Lifestyles (ecological responsible person, carefree waster, un-oriented environmental polluters, technology disclaimer, conscious materialist) are useful for target group segmentation

The following paragraphs shows advantages and disadvantages of behaviour of people in connection with energy efficiency, this overview is not only applicable for final consumers but also for people working for industrial companies:

Energy is not a Status symbol

- The problem with energy is: energy is an abstract topic for people.
- It is a so called „low involvement product"
- Energy doesn´t stimulate peoples and costumers emotions like a car, it is not a status symbol

Past

- People cannot show off with energy „oh look, I have a new heating boiler"
- In the past it was important that energy is available: people had the expectation that energy is available whenever they need it for cooking, watching TV, etc.; energy was only a topic and under discussion when it went off sometimes, e.g. because of a breakdown of the power supply system

Current situation

- Now this is changing slowly
- Energy stimulates the emotions of people more and more; But not in general, it is only for some applications like PV installations; applications like heating boilers and energy control systems still don´t stimulate emotions

The following instruments can be used for the influence of behaviour:

- Legal requirements
- Incentives: Support schemes: support scheme for investments, support schemes für energy consultancy
- Energy cots must reflect the real costs, not supported costs
- Awareness raising campaign: klimaaktiv programme of Federal Ministry of Agriculture, Forestry, Environment and Water Management

Moralism

- Don´t moralism with a marketing campaign „you have to reduce energy consumption because it is the best for our environment“

Summary

- First step: information
- No general marketing campaigns on EE topics
- It is important to create a target group oriented campaign
- Have a clear definition of a target group and her needs
- Have a clear vision how to reach the target group (e.g. Migrants, older people, younger people); every target group needs another picture language
- Campaigns must be emotive and visually attractive; pictures with clear messages, not too much text, no morality
- Tailor made trainings: experts must be trained in another way than non-experts

B.2 CZECH REPUBLIC

This report provides an overview of the industrial sector in the Czech Republic, its energy use and the role of steam. In addition, an overview of the legal framework related to energy efficiency and energy audits is described.

Industrial enterprises

Statistics in the Czech Republic provide information on all enterprises which have more than 20 employees. In the sector Industry there were 186 622 enterprises in 2012, which is divided in industrial sectors in the table below. The categories follow the NACE codes, the European statistical classification system.

Number of enterprises	Industrial sector
186 622	**Industry, total**
359	**Mining and quarrying**
173 889	**Manufacturing**
7 305	Manufacture of food products
1 222	Manufacture of beverages
3 151	Manufacture of textiles
10 784	Manufacture of wearing apparel
840	Manufacture of leather and related products
29 405	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
929	Manufacture of paper and paper products
8 730	Printing and reproduction of recorded media
34	Manufacture of coke and refined petroleum products
1 837	Manufacture of chemicals, chemical products
88	Manufacture of basic pharmaceutical products and pharmaceutical preparations
3 907	Manufacture of rubber and plastic products
6 576	Manufacture of other non- metallic mineral products
908	Manufacture of basic metals
44 076	Manufacture of fabricated metal products, except machinery and equipment
3 353	Manufacture of computer, electronic and optical products
14 753	Manufacture of electrical equipment
5 835	Manufacture of machinery and equipment n.e.c.
1 209	Manufacture of motor vehicles, trailers and semi-trailers
584	Manufacture of other transport equipment
8 116	Manufacture of furniture
8 656	Other manufacturing
5 991	**Electricity, gas, steam and air conditioning supply**
6 383	**Water supply; sewerage, waste management and remediation activities**

Energy consumption

Final energy consumption in industry in 2012 was 339.1 PJ. Non-energy use (industrial processes etc.) in industry in 2012 was 95.7 PJ.

Description of industrial sector

The annual publication of the Ministry of Industry and Trade, *Panorama of the Czech Manufacturing Industry*, gives an overview of the main industrial sectors. The latest publication available includes data for 2013.

The manufacturing industry (MI) represents one of the key sources of GDP in the Czech Republic. In 2013, its share in total gross value added (GVA) amounted to 25.1%, which is 0.4% more than in 2012 and 2.5% more than in 2009. The share of MI in total industry revenues reached 91%.

The long-term leader in total revenues of MI is the production of motor vehicles (CZ-NACE 29), whose share in 2013 amounted to 23%, roughly on the level of the previous year. Second was the manufacturing of fabricated metal products, except machinery and equipment (CZ-NACE 25) with a share of 8.7%, followed by CZ-NACE 28 Production machinery and equipment (8.1%).

The number of persons employed in MI in 2013 over the previous year decreased by 1.8% and amounted to 1,044,732 persons. In 18 sectors, this indicator declined and only five rose. The biggest increase of employees was reported in sections CZ-NACE 25 (+ 1.7%, an increase of 2,359 persons) and CZ-NACE 28 (+ 0.6%, an increase of 686 people). The sharpest drop occurred persons employed in sections CZ-NACE 26 (-7.6%, A decrease of 3,225 persons) CZ-NACE 29 (-1.9%, a decrease of 2,658 persons) and CZ-NACE 10 (-2.5% decline about 2,237 persons).

The gradual improvement in the economic situation had a positive impact on foreign trade ZP, whose turnover (Imports + exports) last year reached a record 463.5 billion 5. CZK and grew by 3.5%. Whereas the exports grew at a faster pace (+ 4.2%) than imports (+ 2.8%), trade surplus rose by almost 12% to 516.9 billion.

The total inflow of foreign direct investment (FDI) into the Czech Republic reported in 2013 compared with the previous year of significant decline. While in 2012 foreign investors invested 156.3 billion CZK in the Czech Republic, a year later, it was only 97.7 billion. CZK, i.e. by almost 59 billion CZK less. Most investment in the form of base capital attracted production in electricity, gas and heat (34.4 bn. CZK) and services (26.6 bn. CZK). Investment in manufacturing handles mainly the production of motor vehicles, trailers and semi-trailers (3.8 bn. CZK) and manufacturing of machinery and equipment (1.4 bn. CZK).

<u>Steam installations</u>

Steam installations are installed in the energy sector and the industry sector.

In the Czech Republic there are statistics from 2010 of all boilers with installed capacity above 200 kWt in all sectors. Total number of boilers is 32,000. Unfortunately in these statistics there is no information about type of the boiler (it is not mandatory to specify the type of boiler), so only for 250 boilers in industry with installed capacity of 1383 MWt we can say that they are steam boilers. Definitely the true number will be much higher than 250.

According to national statistics in manufacturing industry there are currently 197 steam boilers with installed capacity of 394 MWt. These boilers are primarily utilised for process purposes. For only 20 of them it is possible to specify the type of boiler (water tube boilers, etc.).

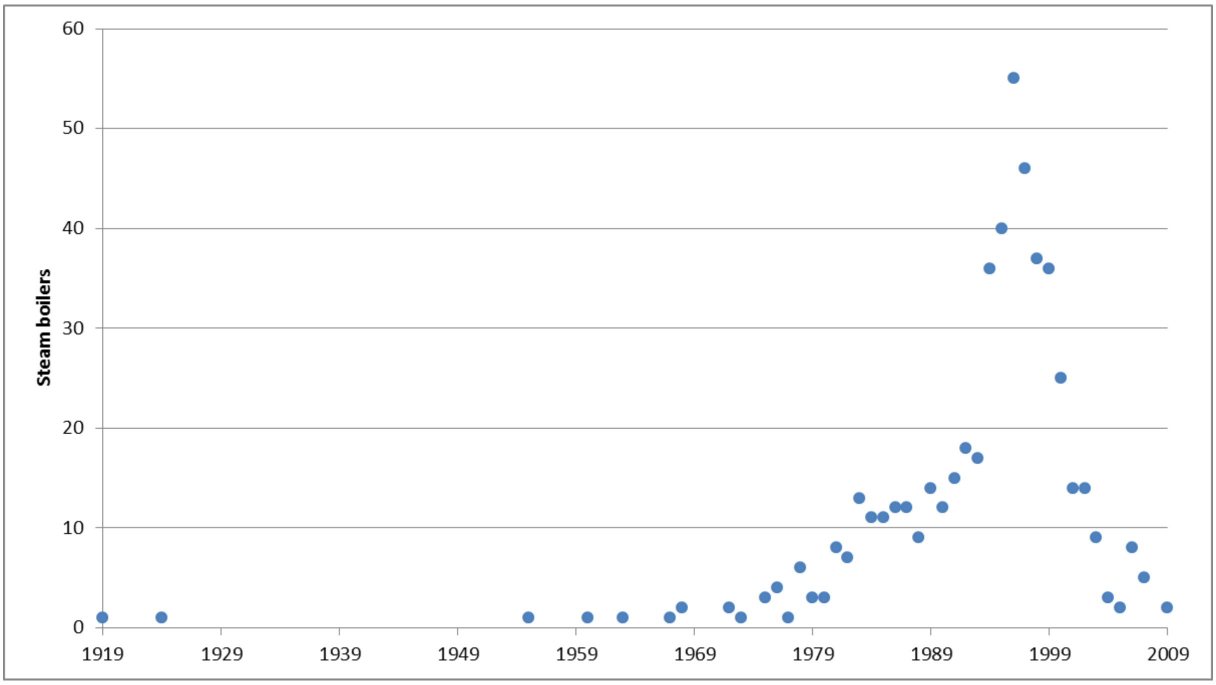
According to available statistics it is possible to specify the fuel type for all boilers. About ¾ of all boilers are fuelled by natural gas. From the 197 steam boilers mentioned:

- 154 boilers are fuelled with natural gas
- 2 boilers are fuelled with propane/butane
- 2 boilers are fuelled with black coal
- 14 boilers are fuelled with brown coal
- 1 boiler is fuelled with coke
- 6 boilers are fuelled with wood
- 10 boilers are fuelled with extra light fuel oil
- 5 boilers are fuelled with light fuel oil
- 2 boilers are fuelled with heavy fuel oil
- 1 boiler is fuelled with diesel oil

The lifetime of the boilers is not registered anymore. Originally, this was registered until 2009 in the registry of air pollution sources (REZZO).

Freely available data are in category REZZO 2 (from 0,3 MWt to 5MWt). Of the total number of 3113 sources, 3016 are outside the energy sector and 522 have been identified as steam boilers and at the same time had their age registered. The age distribution of these 522 boilers is the following:

Age	Number	Percentage
Less than 5 years	20	4%
5-10 years	98	19%
10-20 years	290	56%
20-30 years	89	17%
30 and more years	25	5%
Total	**522**	100%



The average age of a steam boiler in 2009 was 16 years. The table above shows a significant amount of boilers are older than 20 and even 30 years.

In the category REZZO 1 are emission sources with capacity above 5 MWt. The no. of sources here is 3167 and approximately 2000 of them fall outside the energy sector. We estimate that 25% (500 sources) are steam based. It is expected that the average lifetime is lower than for REZZO 2 sources as REZZO 1 sources have to meet stricter emission limits.

Sales figures and developing trends

The only information source available for installation of steam boilers (new or replacements) are annual import and export statistics. Here the number of 40 is given as annual estimate for the last few years. There is, however, no possibility to verify this number.

The total amount of steam boilers is probably decreasing, but we don't have good data to be sure. The reason for assuming a decrease is the general observed trend of replacement of steam boilers by hot water boilers in the energy sector, mainly in district heating plants. According to expert information, this trend is also visible in industrial companies.

Nevertheless, there still are a no. of industrial processes in industries, e.g. chemical industry, food industry, that require steam and replacement by hot water is not possible.

Energy use and potential

Regarding energy use of industrial steam boilers, the 197 boilers with capacity 394 MWt have a heat production of 1.97 PJ annually. The latest available information here was from 2010.

About the share of steam in industrial energy use, we can make some rough estimates[10]:

[10] Although no. are not fully comparable due to different years, the date give a rough estimate of the share of steam.

- If we compare this number with the total energy consumption of 339.1 PJ per year for industry, we come to a share of less than 1%
- When comparing the steam heat production with the share of industry that is not related to heat / power generation (non-energy use) – 95.7 PJ, we see a share of 2%.

There are no studies available that would give general / aggregated information on the savings potential of steam in industry. Only information from single energy audits carried out in industrial companies. It is therefore not possible to give a savings potential related to steam processes country-wide. This information has to be based on single audits.

From company questionnaires we have the information that potential energy savings in steam processes are between 10 and 20%. The potential is even higher (up to 30%) in companies where a large savings potential remains (e.g. due to old boilers).

Among the most common steam saving measures mentioned, Heat recovery (exhaust, blowdown, condensate return) has probably the most potential, although the following options should not be excluded:

- Operation (operation pressure, stand still, idle mode (in case of no demand – no production))
- Control (automated blow down, exhaust oxygen,…)
- Distribution (steam traps, control and design of heat exchangers,…)
- Replacement of old steam boilers by new ones. The average age of steam boilers is about 16 years, so a significant amount of boilers remains older than 20 years that are not really efficient.

Apart from that, replacement of steam boilers by hot water boilers can bring savings, but question is if this can be considered as a steam saving measure. And not in all companies this is a possible option due to the need to use steam for the production process.

Measures that usually have been taken already are:

- Installation of economisers
- Optimizing blow down control
- Condensate return
- Air pre heating
- Boiler shut down during stand still

<u>Sectors and processes (main industrial users)</u>

The table below shows the energy consumption per industrial sector split by NACE sector.

Energy Consumption in industrial sectors by CZ-NACE 2008-2013						
	2008	2009	2010	2011	2012	2013
	GJ					
NACE Sector	**1 873 146 364**	**1 758 094 835**	**1 775 004 841**	**1 045 208 515**	**1 009 239 589**	**966 127 875**
05 Mining of coal and lignite	112 947 976	108 458 239	105 100 054	59 642 662	59 895 437	55 467 757

06 Extraction of crude petroleum and natural gas	610 149	628 146	270 831	208 623	214 419	152 558
07 Mining of metal ores	3 288 227	2 915 460	2 859 827	1 435 985	1 304 141	1 308 067
08 Other mining and quarrying	6 852 628	6 494 932	6 302 057	3 354 706	3 128 590	3 063 651
09 Mining support service activities	101 905	134 600	469 303	95 670	114 311	334 481
10 Manufacture of food products	41 918 107	44 685 613	43 817 383	18 513 624	19 638 124	20 359 934
11 Manufacture of beverages	9 019 441	8 630 512	8 767 553	3 924 550	3 793 402	3 778 301
12 Manufacture of tobacco products	352 494	314 648	301 154	194 690	181 131	178 004
13 Manufacture of textiles	8 090 230	7 567 256	7 189 703	4 537 829	4 491 273	4 381 777
14 Manufacture of wearing apparel	998 906	1 182 772	815 942	431 751	691 916	375 763
15 Manufacture of leather and related products	205 810	239 302	269 305	118 646	124 079	150 192
16 Manufacture of wood and of products of wood and cork	6 331 259	5 256 930	5 685 861	3 896 803	3 693 071	3 770 991
17 Manufacture of paper and paper products	23 569 759	23 927 895	22 789 395	13 445 277	13 613 577	12 537 219
18 Printing and reproduction of recorded media	1 683 223	1 465 015	1 433 924	1 173 851	1 083 501	1 037 521
19 Manufacture of coke and refined petroleum products	66 910 892	51 828 443	55 599 844	34 687 033	31 954 286	30 609 764
20 Manufacture of chemicals and chemical products	104 842 756	99 798 626	102 033 299	54 057 609	49 087 635	49 128 183
21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	4 541 947	3 056 201	3 056 191	1 852 677	1 463 821	1 439 008
22 Manufacture of rubber and plastic products	11 566 220	11 098 133	12 490 779	9 300 108	9 131 671	10 515 645
23 Manufacture of other non-metallic mineral products	83 590 140	80 109 188	75 362 850	36 334 263	36 484 248	32 245 442
24 Manufacture of basic metals	219 622 731	180 520 236	172 960 668	168 348 189	161 507 803	162 479 206
25 Manufacture of fabricated metal products	21 273 775	22 167 101	22 387 322	11 778 226	12 385 771	12 659 706
26 Manufacture of computer, electronic and optical products	1 289 407	1 659 786	1 634 827	1 422 795	1 782 857	1 736 605
27 Manufacture of electrical equipment	7 368 769	7 743 240	10 491 353	4 943 829	5 078 613	8 183 873
28 Manufacture of machinery and equipment.	17 793 642	17 393 231	17 548 436	9 916 429	9 621 527	9 794 735
29 Manufacture of motor vehicles	24 481 986	25 476 141	23 929 243	15 661 821	15 730 708	15 525 552
30 Manufacture of other transport equipment	5 184 931	5 517 642	5 943 508	2 291 289	2 461 062	2 537 296
31 Manufacture of furniture	1 550 605	1 505 113	1 690 847	981 034	960 318	1 079 221
32 Other manufacturing	1 744 899	1 848 020	1 873 271	1 242 388	1 266 620	1 310 480
33 Repair and installation of machinery and equipment	2 581 566	2 362 116	2 190 088	1 492 097	1 490 711	1 496 030
35 Electricity, gas, steam	1 082 831 983	1 034 110 300	1 059 740 023	579 924 061	556 864 965	518 490 913

There is no general, aggregated information available of the distribution of energy consumption over different processes. It's only available in energy audits carried out in single industrial companies. There is no way to compare single audits.

Organisation of enterprises

The Confederation of Industry of the Czech Republic is the most important interest group of industry and commerce in the country. The Confederation is an official partner for Government officials, for Regional Governments' representatives, for trade unions, research organizations and technical universities. Members of the confederation are 27 branch associations, 7 of them can be considered as being the target group for STEAM-UP as they have members (industrial companies) that use steam. These are the following:

Association of the Pulp and Paper Industry
Association of the Glass and Ceramic Industry of the Czech Republic
The Steel Federation of the Czech Republic
Association of Chemical Industry of the Czech Republic
The Cement Manufacturers Association
Czech Lime Association
Association of Foundries of the Czech Republic

Of importance are also the following associations that are not a member of the Industry Confederation:

- Chamber of Food Industry
- Association of Textile-Clothing–Leather Industry

These associations are member of the Economic Chamber of the Czech Republic. The Economic Chamber is the main interest group of medium and small companies, although some large firms are also member.

All branch associations bring together industrial companies from the branch and the official interest group from the branch.

Especially the ones in heavy industry share information about energy efficiency. Information shared between companies on energy savings differ per association, as some information related to energy use in industrial processes companies do not like to share with their competitors in the sector. Company representatives from chemical industry mentioned that their sector organisation provided useful information on energy savings.

Legislation and regulation (steam and energy efficiency)

The main European directive that is applicable for energy efficiency in industry (and thereby also steam) is the Energy Efficiency Directive (2012/27/EU).

The main national law that concerns energy efficiency is the a. Energy management Act 406/2000 Sb. (Zákon o hospodaření energií). Main obligations covered in the law are:

- Effective use of energy sources and energy distribution
- Energy audit obligations
- Energy specialists and their certification
- Boiler controls

The law has been recently amended to include the provisions of the EED. Standards for boilers are also mentioned in the Energy management Act. The Act refers to a number of Decrees related to energy efficiency standards and energy audits, etc.

For boilers above 200 kW, there is a decree on:

- Minimal energy efficiency of using energy in heat and electricity generation (Vyhláška o stanovení minimální účinnosti užití energie při výrobě elektřiny a tepelné energie 441/2012 Sb.),

For distribution of heat and cold, the following technical decree exists:

- Decree no. 193/2007 Coll. laying down the details of energy use efficiency in heat distribution and internal distribution of heat and cold (Vyhláška č. 193/2007 Sb. kterou se stanoví podrobnosti účinnosti užití energie při rozvodu tepelné energie a vnitřním rozvodu tepelné energie a chladu) – In general, distribution of thermal energy must comply with this decree and according to it losses in the distribution system and propose recommended insulation is calculated.

Boilers up to 200 kW are covered under:

- Air Protection Act 201/2012 Sb. (Zákon o ochraně ovzduší) – not related to efficiency, but emissions only.

Apart from the abovementioned legislation, there is a technical standard on the construction of steam and hot water boilers:

- ČSN 070620 - (Konstrukce a výstroj parních a horkovodních kotlů) Construction and equipment of steam and hot water boilers

This standard, among others, states minimum requirements for boiler insulation. The insulation should be such that the outside surface temperature of the boiler during operation should not be higher than 45˚C (safety reasons).

Regulation related to steam boilers

Steam boilers are checked on a regular basis and this is mandatory according to Decree No. 194/2013 Sb. Boiler inspection and distribution of thermal energy.

In the inspection report it is recorded if and when the boiler was serviced, revision of flue gas paths, protocol for measuring emissions, evidence of consumed electricity, heat, water, etc.

Boiler capacity	**Fuel**	**First control (years)**	**Next inspection**	
			System is continuously controlled (years)	**System is not continuously inspected (years)**
From 20 kW up to 100 kW	all	10	10	10
Above 100 kW	Solid and liquid	2	10	2
	gaseous	4	10	4

A regular check is being performed on:

- Efficiency
- Integrity of pressure equipment

What is not checked in the framework of this decree is/are:

- Emissions (O_2, NO_x,…) → but separate emission standards and exist
- Boiler water quality and composition
- Energy saving opportunities
- Steam traps

No other auditing tools or procedures are available, specifically related to steam.
There is only a general energy audit methodology set out in the Energy management Act 406/2000 Sb and Energy Audit Decree 480/2012 Sb. No specific provisions on energy audits in steam

Support programmes to stimulate the rational use of energy and/or steam

The main support programmes related to energy efficiency are those financed through Structural and Cohesion Funds (SCF):

a. Operational Programme Environment 2007-2013 and 2014-2020 – this programme is aimed at the public sector and also supports energy efficiency measures, but no industrial / steam processes.
b. Operational Programme Enterprise and Innovation for Competitiveness (OPPIK - 2014-2020) – this operational programme provides support for the private sector. Grants are between

45 and 65% depending on size of the company (SMEs receiving higher percentages). Activities supported are following:

  i. Modernisation or replacement of existing energy production facilities
  ii. Installation of measurement and control systems;
  iii. Modernisation, reconstruction and loss reduction in electricity and heat distribution systems in buildings and production plants;
  iv. Measures to improve the energy performance of buildings in the business
  v. Re-use of waste energy in production processes;
  vi. Improvements in energy performance and energy efficiency in production and technological processes;
  vii. Installation of renewable energy sources for own consumption;
  viii. Installation of a cogeneration unit with maximum use of electricity and thermal

c. The predecessor of the OPPIK programme, the Operational Programme for Enterprise and Innovation (OPPI) – 2007 – 2013 financed a large no. of energy efficiency projects in industry, some were related to steam processes).

Apart from the abovementioned grant programmes there is the Green Initiative from the EIB (European Investment Bank)[11]:

Two banks in the Czech Republic (Česká spořitelna & Raiffeisen bank) have a special financial product for energy efficiency and renewable energy investments, using funds from EIB. These products include a 10% grant for borrowers after realisation. The product is primarily aimed at SMEs, there is no information so far that steam projects have been financed.

Steam Experts and Expertise

Steam expertise is not (yet) organised in a certain way. Association of energy auditors are not specifically focused on this. Energy auditors (since 2013 renamed to energy specialists) are usually specialised in a certain field, industry or buildings. But there is no group of energy specialists primarily specialised in steam.

Energy auditors are organised within the Association of Energy Auditors. A list of certified energy auditors is kept by the Ministry of Industry and Trade. This list shows specialisation of energy auditors, e.g. whether they are specialised in industrial energy efficiency or energy efficiency in buildings. Technical consultancy companies, like ENVIROS, employ industrial energy efficiency experts with knowledge of steam processes.

Industrial companies hire such auditors, as audits have to be carried out by external expertsOther key players in the field of steam use are:

- Industrial enterprises – they have internal experts, expertised in industrial processes that include steam, trained internally.
- Equipment suppliers
- Technology suppliers

[11] http://europa.eu/rapid/press-release_BEI-13-132_en.htm

Energy Auditing Practises

Energy Management Act 406/2000 Coll., (amended in 2012) - adopted to contribute to efficient use of natural resources and energy. The Act defines:

- energy auditor (since 2012 renamed energy specialist)
- energy audit
- energy expert opinion

Ministerial Decree 480/2012 Coll. to the Energy Management Act lays down the details for energy auditing and energy expert opinions (to a large extent covering requirements of Annex VI of the EED). A new decree is in preparation fully covering all requirements from the EED.

In addition there are Internal Ministerial Documents providing methodological basis for

- energy auditor/specialist candidates to pass the energy audit exam,
- list of questions,
- the extent of knowledge,
- publicly available list of certified energy auditors

Energy audit obligations

Energy Audit obligations exist for large companies. It already exists from 2001 onwards for private companies with energy use of 35,000 GJ. Those companies were obliged to carry out an energy audit according to the energy audit methodology and it had to be carried out by an energy auditor certified by the Ministry of Industry and Trade. There was no obligation to repeat the audit at a certain period of time.

In the framework of the new Energy Efficiency Directive (EED), the audit obligation has been changed. It is now mandatory for large companies only (those that are above the EU definition of SMEs) and the audit has to be repeated every 4 years. Companies that have an energy and/or environmental management system in place in line with ISO50001 / ISO14001 are exempted from the obligation (as an audit is needed anyway). The energy audit decree is to be amended by the end of the year.

Another main reason for energy companies to carry out energy audits is to apply for grants under the operational programmes. Applications for grants for energy efficiency investments require an energy audit (as part of the application documentation).

From 2001 onwards, audits are registered by the State Energy Inspectorate. Since 2014, audit reports are stored in an online database.

So far, the energy audit recommendations have no general follow-up, only when they are part of a grant application.

There is also an obligation for public entities to carry out energy audits (above 1500 GJ annual energy use). Here, the State Energy Inspectorate may oblige some public organisations to carry out energy measures. But no steam measures are included here.

There are no statistics on the implementation rate of identified energy efficiency measures from energy audits.

Management Practises

In the Czech Republic ISO9001 is common among larger, but also small and medium enterprises. ISO 14001 is becoming more common, ISO50001 so far only among specialised companies.

The ISO survey 2013 showed the following no. of certified companies in the Czech Republic.

- 16 companies certified under ISO 50001
- 4792 companies certified under ISO 14001
- 12679 companies certified under ISO 9001
- 159 countries certified under ISO 22000

These data show the large number of companies certified under ISO 14001 and ISO 9001. The low interest so far in ISO 50001 could be caused by the fact that some companies already included energy issues under ISO 14001 and therefore see no reason for adopting ISO 50001.

Assessment of investments

Although no general information is available on ways that companies assess investments related to energy efficiency, there is some indication that such investments are assessed though SPP (Simple Payback Period), NPV (Net Present Value) & IRR (Internal Rate of Return). SPP is usually the indicator that enables companies to make a quick assessment of the payback of a certain measure. Especially when there is an internal rule to only implement measures with max. two or three years back pack, SPP is sufficient to make a quick selection. For more detailed analysis, NPV and IRR is usually applied. Some companies also mentioned the use of TCO or LCC.

Non-energy benefits, with the exception of financial benefits directly related to energy savings do usually play a less important role.

Companies mentioned as additional benefits, environmental benefits (and meeting stricter emission standards), decrease of maintenance costs and additional benefits to the production process.

Behaviour and energy efficiency

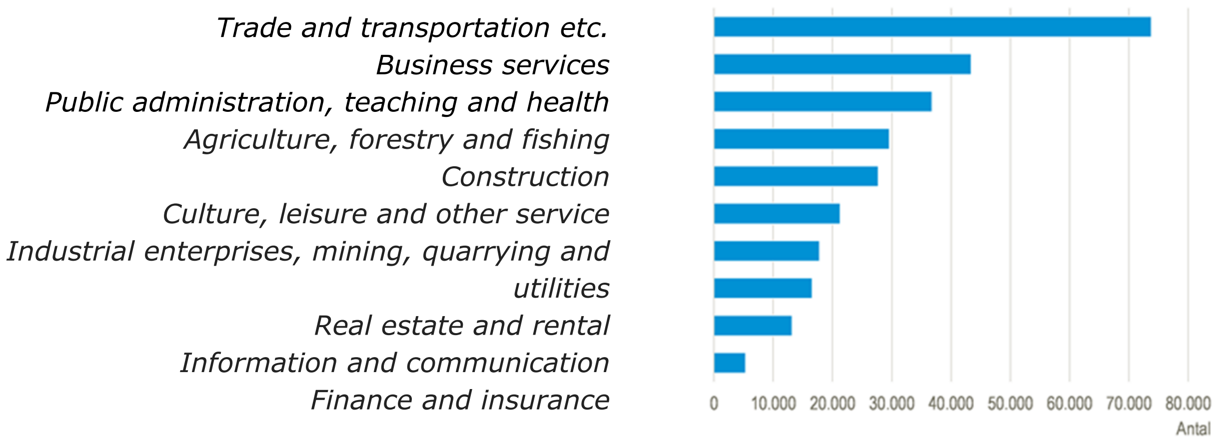
So far, no studies are known in this field. Behavioural science in this field is mainly looking at behaviour of households in refurbished buildings.

B.3 DENMARK

Industrial enterprises

According to Statistics Denmark, there were 18.000 industrial enterprises in Denmark in November 2013 (http://www.statistikbanken.dk/statbank5a/selectvarval/saveselections.asp). The industrial enterprises can be divided into 35 divisions (Mapping of energy consumption in industrial enterprises - Jan 2015). The energy consumption of the industrial sector represent 47.4 percent of the collective energy consumption in the Danish industry and amounts to 94,168 TJ/year in 2012. (Mapping of energy consumption in industrial enterprises - Jan 2015).

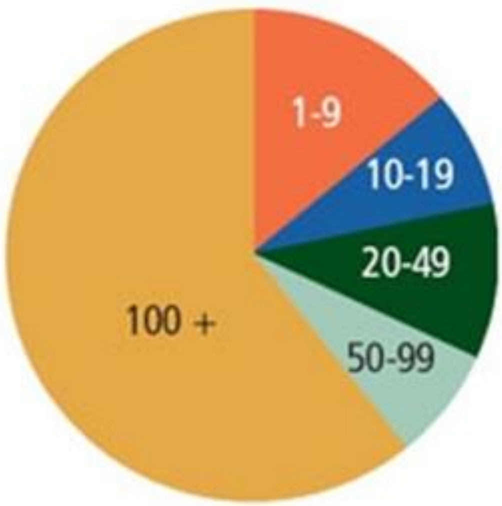
Places of work by industry. End of November 2015.



The table shows the number of workplaces in Denmark. In November 2013 there were 286,000 workplaces in Denmark. (www.dst.dk) of which 18,000 were in industrial enterprises, mining, quarrying and utilities.

The Danish business structure has undergone enormous change in recent decades. Denmark has changed from being an agricultural and industrial society to becoming a society in which services are predominant.

There are approximately 300,000 businesses in Denmark. The Danish business structure is characterized by many small businesses and only few large companies. 93 percent of Danish businesses have ten employees or less.



Number of full time employees by company size. 2007.

Nevertheless, 1.3 million full time employees – or 63 percent of all the total number of full time employees – work in the largest companies with 100 employees or more.

Number of companies and full time employees by business sector 2011.

	Number	
	companies	Full time employees
Agriculture, forestry and fishing	32.705	29.166
Mining and quarrying	214	3.884
Industrial enterprises	15.715	263.558
Utilities	1.793	9.854
Water supply and waste disposal	2.590	8.905
Construction	31.575	118.160
Trade	44.681	301.453
Transportation	12.077	115.790
Hotels and restaurants	13.670	45.993
Information and communication	14.588	86.414
Finance and insurance	8.983	79.283
Real estate and rental	27.220	28.257
Knowledge intensive services	31.781	106.613
Travel agents, cleaning and other operational services	15.781	69.078
Public administration, teaching and health	284	634.422
Teaching	5.311	103.833
Health and social services	18.677	61.490
Culture and leisure	6.351	22.869
Other services etc.	16.474	45.125

Unknown activity	*188*	*191*
Total	***300.733***	***2.134.338***

Today, almost three out of four employees work in the service sector. These include private services for instance trade, transportation, finance, knowledge intensive services and personal services – and public service to citizens.

Within the industrial sector you will find the very large companies, even though they represent less than one in ten of all companies in Denmark.

Almost half of all the places of work are placed in Jutland, while almost one third is found in and around the Danish capital, Copenhagen.

On average, there are about ten jobs per workplace, but the workplaces are of varying sizes, like the companies.

The vast majority of the workplaces are small. Two thirds of the workplaces have fives jobs or less. In fact, there are only about 8,500 workplaces in Denmark that have 50 jobs or more.

The very small workplaces are found particularly in agriculture and fishing. Here, over 90 percent of the workplaces have five jobs or less. Most workplaces consist of only one job, which is usually the owner of the farm or the fishing boat.

The large workplaces are concentrated in and around the large cities and especially in and around Copenhagen.

The largest workplaces are found within the industrial sector and within the service sector. In the industrial industry, the largest workplaces are for instance factories that produce industrial products or food products.

In the service sector, it is particularly within public administration that many of the workplaces are large.

(https://www.ug.dk/job/artikleromjobogarbm/omarbejdsmarkedet/erhvervsstruktur/virksomheder-i-danmark)

Installations

There is no evidence of how many steam boilers are in operation in Denmark or of the installed capacity today. In 2006 when the Danish public authority Arbejdstilsynet (labor inspectorate) undertook an inspection of steam boilers, they had 4.500 steam boilers in their register that were subject to public inspection. Today, inspection of boilers is performed by accredited inspection bodies in Denmark and notified bodies from the EU.

For steam production, shell boilers and water tube boilers are typically used.

The types of fuel in steam boilers are typically gas and oil, but renewable energy is becoming more and more popular.

The lifetime of steam boilers are typically twenty years or more. New boilers are almost only installed, when a new industry opens.

Sales figures and developing trends

It has not been possible to find documentation of how many steam boilers are installed annually. However, the number of steam boilers are anticipated to be declining (based on subjective estimates from Inspecta), partly because steam is substituted by hot water (where possible), but also because of the precautions required for the application of steam.

Energy use and potential

In Denmark, no evidence been produced of the amount of energy used for steam production in the industrial sector. Nor has evidence been produced of the percentage of energy used for steam production in relation to the total industrial energy use.

Material has not been developed that describe the savings potential of steam in the industrial sector.

It is possible to achieve energy savings with steam boilers, however it would be desirable to divide the process into three levels: steam production – distribution – use.

Steam production: This includes the boiler, vents and burns.

- Optimization of combustion by improving control of excess air (loss of gas in pipes) for example frequency control of boiler blower
- Preheating of combustion air
- Retrofitting of economizer
- Insulation of poorly insulated areas of the boiler
- Pre-heating of feed water
- A good control of the conductivity of the condensate will also ensure that it is not necessary to discarded of treated water
- Heat recovery of condensate

Distribution: Steam line to the place of consumption and the condensate.

- Isolate the steam pipes and valves
- Reduction of steam leaks

Use:

- Reduction of steam pressure when there is no production
- Are there new technologies that can replace steam?

Sectors and processes

	Sectors	**NR177 code**	**Energy consumption**	**Percent**
1	Agriculture	010000	23,301	11.7

2	Horticulture	010000	5,034	2.5
3	Agricultural contractors	010000	2,505	1.2
4	Forestry	020000	999	0.5
5	Fishing	030000	5,005	2.5
6	Extraction of gravel and stones etc.	080090	3,342	1.7
7	Slaughterhouses	100010	4,044	2
8	Fishing industry	100020	1,753	0.9
9	Dairies	100030	5,771	2.9
10	Bakeries, bread factories, etc.	100040	2,718	1.4
11	Produkction of prepared animal feeds	100050	2,134	1.1
12	Production of sugar	100050	3,313	1.7
13	Other food industries	100050	3,933	2
14	Beverage industry	110000	2,065	1
15	Tobacco industry	120000	96	0.05
16	Textile industry	130000	802	0.4
17	Clothing industry, leather and footwear industry	140000,150000	109	0.1
18	Wood industry	160000	4,197	2.1
19	Paper industry	170000	2,683	1.3
20	Printing companies etc.	180000	803	0.4
21	Production of industrial gasses	200010	463	0.23
22	Production of enzymes etc.	200010	2,013	1.1
23	Production of other basic chemicals	200010	1,546	0.8
24	Production of paint and soap etc.	200020	4,484	2.3
25	Pharmaceutical industry	210000	3,170	1.6
26	Plastic and rubber industry	220000	2,820	1.4
27	Glass and ceramic industry	230010	1,909	1

28	Production of cement	230020	10,358	5.2
29	Production of bricks etc.	230020	1,292	0.7
30	Production of asphalt and roofing felt	230020	1,707	0.9
31	Production of rock wool	230020	2,026	2
32	Other concrete industry	230020	3,294	3
33	Production of metal	240000	3,041	1.5
34	Metal product industry	250000	4,621	2.3
35	Production of of computers and communication equipment etc.	260010	476	0.2
36	Production of other electronic devices, electric motors, etc. as well as wires and cables	260020,270010,270020	1,073	0.5
37	Production of household appliances, lamps, etc.	270030	248	0.1
38	Production of engines, windmills and pumps	280010	3,145	1.6
39	Production of other machines	280020	2,916	1.5
40	Production of motor vehicles and parts	290000	613	0.3
41	Production of ships and other means of transportation	300000	267	0.1
42	Furniture industry	310000	2,516	1.3
43	Production of medical instruments, etc.	320010	254	0.1
44	Toys and other manufactoring companies	320020	622	0.3
45	Repair and installation of machinery and equipment	330000	1,207	0.6
46	Car dealerships and - workshops, etc.	450000	5,498	2.8
47	Wholesale	460000	16,198	8.1
48	Retail	470000	12,301	6.2
49	Hotels	550000	1,824	0.9
50	Restaurants	560000	5,359	2.7
51	Information and communication	580000-630000	6,946	3.5

52	Finance and insurance	640000-660000	2,539	1.3
53	Real estate and rental of commercial properties	680000	2,264	1.1
54	Knowledge intensive services	690000-750000	5,192	2.6
55	Travel agents, cleaning and other operational services	770000-820000	5,220	2.6
56	Culture and leisure	900000-930000	2,406	1.2
57	Other services (including laundries and dry cleaners)	940000-960000	2,106	1.1

	Industry	
End use	**TJ**	**Percent**
Conversion – and net loss	5,363	8.0
Heating/ boiling	14,402	21.6
Drying	12,802	19.2
Evaporation	4,511	6.7
Distillation	2,295	3.4
Bruning/sintring	3,886	5.8
Melting / casting	3,421	5.1
Other process heating up to 150°C	1,389	2.1
Other process heating over 150 °C	3,215	4.8
Transportation for work	982	1.5
Transportation	4,382	6.6
Room heating	10,183	15.2
	66,831	100

The table shows fuel and district heating consumption by end use (Mapping of energy consumption in industrial enterprises - Jan 2015).

	Industry	
End use	**TJ**	**Percent**
Heating/ boiling	251	0.9
Drying	407	1.5
Evaporation	85	0.3
Bruning/sintring	8	0.0
Melting / casting	1,641	6.0
Other process heating up to 150°C	22	0.1
Other process heating over 150 °C	421	1.5
Transportation for work	8	0.0
Room heating	125	0.5
Energy consumption of heat pumps	399	1.5
Lighting	1,832	6.7
Pumping	2,635	9.6
Room Cooling	235	0.9
Refrigerator / freezer (excl. room cooling)	2,567	9.4
Ventilation	2,093	7.7
Fans	2,562	9.4
Compressed air	2,767	10.1
Hydraulics	665	2.2
Other electric motors	7,312	26.9
IT and other electronisc	572	2.1
Other electricity use	731	2.7
Sum	27,338	100

The table shows electric consumption by end use (Mapping of energy consumption in industrial enterprises - Jan 2015).

The companies in the labour market gather in groups or sectors that produce, process or trade the same type of goods or services for example construction, agriculture, and the metal industry. These groups are called sectors.

Many sectors have formed sector associations that promote common interests and peer questions. Furthermore, they assist members with legal and professional advice, among other things.

The described sectors have been divided into industrial classification by Statistics Denmark; into the Danish Industrial Classification 2007 (DB 07) based on the EU's NACE.

The sector associations contribute to a greater or lesser extend with general advice and guidance regarding energy efficiency within the industry. However, dependent upon how energy intensive the industry in question is.

Legislation and regulation

In Denmark, the inspection of pressure equipment is regulated by the European Parliament and Council Directive 97/23 / EC of 29 May 1997 on pressure equipment. In Denmark, the rules are implemented by Arbejdstilsynet (labor inspectorate) via Executive Order no. 694 of 10 June 2013 on the design of pressure equipment and the Executive Order no. 100 of 31 January 2007. The latter which establishes requirements for verification of the equipment design, installation and subsequent periodic examinations.

The inspection must be carried out by an inspection body that is accredited by DANAK or an equivalent recognized accreditation body.
The inspection body makes installation control of the equipment prior to first use or after repair or relocation.

There are no national guidelines that indicate efficient use of energy in relation to steam boilers. However, there is a Danish subsidy scheme that supports conversion from fossil fuels to renewable energy sources, but as such it does not support more efficient use.

Check and audits

The inspection body carries out periodic inspections at fixed intervals to ensure that the equipment continues to meet the requirements for design and layout and that is maintained in accordance with applicable rules. Once annually, an external inspection is performed and every four years another internal inspection is carried out.

If the company has a steam boiler, it must appoint a person with boiler attendant certificate to monitor the boiler and carry out regular checks. Boiler operator training is achieved by taking a course in 2 x 4 weeks with relevant work experience. (http://www.hoverdal.dk/Kursusbeskrivelser/Kedelpasseruddannelsen.htm)

Under the rules of Arbejdstilsynet (labor inspectorate), the boiler can be allowed to operate without constant monitoring for up to 24 hours. However, the equipment must be checked by an expert company at least every three months. Alternatively, the boiler can be equipped with safety equipment approved for operation without constant monitoring for up to 72 hours (new rules). In that case, the equipment must be checked by an expert company at least every six months.
Check this out again at: http://www.dakitek.dk/dampkedler-lovpligtigt-eftersyn.aspx

The boiler attendant performs the daily operations and maintenance of the associated help equipment and production equipment. He is also responsible for the daily operations and maintenance of water treatment and water treatment equipment and performs the necessary analyses on raw water, make-up water, feedwater, condensate and boiler water. He performs troubleshooting based on analytical results and performs the legal controls of safety equipment. (check for overpressure / safety valves).

Steam Experts and Expertise

It has not been possible to obtain records of steam experts in Denmark. Nor has it been possible to find expert platforms, organizations or websites.

Vocational schools that train boiler attendants exists in MU Hoverdal in Spjald for instance. Furthermore, there are private providers of courses in steam for example Gustaf Fagerberg A/S. http://www.fagerberg.dk/Events/DAMPTEKNISK-KURSUS--d-22012015-kl-900 No complete range of courses exist.

Companies that use steam is required to employ a boiler attendant.

In order to reduce the consumption of steam, the company can contact an energy consultant or supplier of equipment to investigate whether the company's steam consumption can be reduced.

Key players in Industrial Steam

There are a number of equipment suppliers in the steam industry for example TTBoilers, Vagn Hansen, Danstoker, Lin-Ka og Spirax. Several boiler producers have moved their production of boilers out of Denmark because of lower production costs. Now they only have their design departments in Denmark.

Energy Auditing Practises

In Denmark, the EU energy efficiency directive from October 2012 is implemented. As a result, large companies are required to perform an energy audit, which must be approved by a registered energy consultant. The energy audit must be performed every four years. Companies are not obliged to implement the energy saving measures that the energy audit identifies.

Instead of performing an energy audit, the company can introduce ISO 50001 or ISO 14001 with an addition within energy. DEA is responsible for ensuring that all companies perform the energy audits within the set time limit.

Energy consumption is a major expense for companies in Denmark. As a result, it makes good sense for most companies to implement energy saving measures.

Industrial enterprises are only obliged to implement energy saving measures if they enter into a voluntary agreement with the DEA. They can only be considered for this if their NACE code is indicated on a special list of electricity-intensive companies. In return, they get reimbursed for part of the PSO levy they pay.

At present, none or very few energy audits have been conducted, and there are no reports that the audits will be followed up by motivational approaches.

The grid companies in Denmark have been imposed an energy saving target. Therefore, they have the possibility of subsidizing energy-saving measures, including more efficient use of steam or substitution of steam, if the energy saving measures produce savings that are in accordance with the guidelines set by the DEA.

To obtain approval as a registered energy consultant, the consultant must demonstrate experience in project management, energy conservation and energy management and energy control, and have a relevant basic educational background, for example in engineering.

Management Practises

ISO 9001, ISO 14001, ISO50001, ISO22000 and OHSAS 18001 standards are widely used among industrial companies in Denmark.

A complete list of companies in Denmark that are certified by the above standards does not exists, because the certification bodies do not establish a national inventory. They typically only establish inventories for their own customers.

In addition to the certified systems, Denmark has an energy audit scheme and contractual arrangements with the DEA (reimbursement of PSO levy), which are national schemes. They were both introduced in 2015.

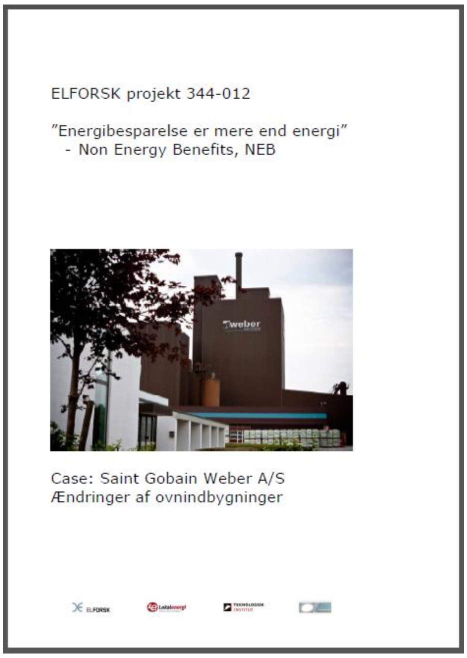
The financial assessment tools that are used in Denmark are typically IRR (internal rate of return), SPP (simple payback).

Non Energy Benefits

Non Energy Benefits often constitute a very small part of the decision making when introducing energy saving measures. Albeit Non Energy Benefits can mean a significantly more positive business case.

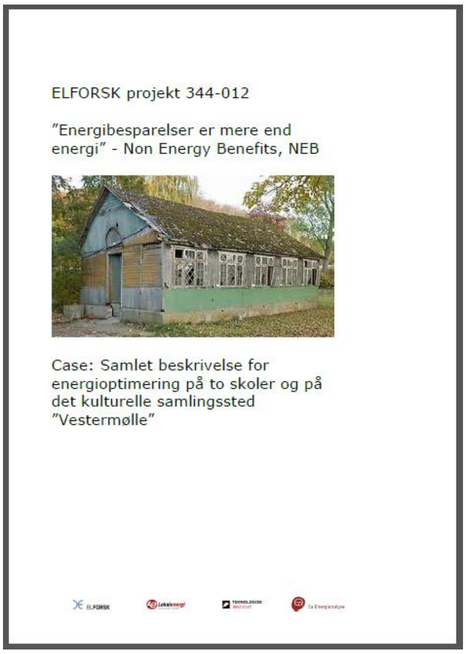
A practice has not been incorporated in Denmark for the identification and quantification of Non Energy Benefits. However, a completed and an in-process research and development project exist which collects experience in a web-based tool. This tool can subsequently be used by businesses or institutions to identify Non Energy Benefits, but also to quantify them. AURA Raadgivning participates as a project manager in the project.

Se: http://neb.teknologisk.dk/PDF/case%20weber.pdf
http://neb.teknologisk.dk/PDF/Case%20Stilling%20Skole%20Skovby%20Skole%20Vesterm%c3%b8lle%202013%2012%2020.pdf


ELFORSK projekt 344-012

"Energibesparelse er mere end energi"
- Non Energy Benefits, NEB

Case: Saint Gobain Weber A/S
Ændringer af ovnindbygninger


ELFORSK projekt 344-012

"Energibesparelser er mere end energi" - Non Energy Benefits, NEB

Case: Samlet beskrivelse for energioptimering på to skoler og på det kulturelle samlingssted "Vestermølle"

http://www.elforsk.dk/ELFORSK/Projekter/ProjectSearch/ProjektInfo.aspx?proji=344-012

http://www.elforsk.dk/ELFORSK/Projekter/ProjectSearch/ProjektInfo.aspx?proji=346-039

Behaviour and energy efficiency

Work on energy efficient behavior has been ongoing in Denmark during the past 15-20 years. The work of individual companies is ongoing, but a comprehensive overview of where the efforts have been is missing. Therefore, there is no overview of which tools and follow-up methods that have been used in the companies. It may be mentioned that Post Danmark has worked intensively with energy efficient behavior and have demonstrated savings of approximately 20 percent of their energy consumption. Several municipalities have also worked with energy efficient behavior in several cases related to the implementation of ESCO projects.

http://www.elforsk.dk/ELFORSK/Projekter/ProjectSearch/ProjektInfo.aspx?proji=336-050

http://www.elforsk.dk/ELFORSK/Projekter/ProjectSearch/ProjektInfo.aspx?proji=341-022

http://energiforskning.dk/en/projects/detail?program=All&teknologi=65&field_bevillingsaar_value=&start=&slut=&field_status_value=All&keyword=&page=26&lokalitet=All

B.4 GERMANY

Industrial enterprises

1. *How many industrial enterprises are active in your country? Please give a division per sector. (BMWI) (Anwendungsbilanzen für die Endenergiesektoren in Deutschland in den Jahren 2011 und 2012 – AGEB – 2014)*

Germany is composed by a combination of big large concerns and midsize companies, which are especially very successful on the international domain. The overall number of companies in Germany in 2014 was 22400, which provides approximately 5,3 Million jobs and reach profits of 1,3 Trillion euros. A table with the most important industrial enterprises is shown below:

Table 1: Larges Industry-sectors in Germany 2014 (BMWI)

Industry	Profit in Billion euros	Jobs in thousand
Automobile	368	755
Machine construction	219	933
Metal	185	746
Chemistry/Pharmaceutical	182	419
Food	154	455
Electrical	150	636
Construction	99	757

Table 2: Number of enterprises in the different sectors in Germany 2012 (Destatis, Statistische Bundesamt - Unternehmensregister)

Industrial sector	Enterprise				
		from ... until... number of cowokers in 2012			
	Overall	0 bis 9	10 bis 49	50 bis 249	250 and more
Stone and mineral industry	2 355	1 749	475	105	26
Process industry	252 803	189 136	44 313	15 333	4 021
Energy supply	60 473	59 144	668	474	187
Water supply, water- and waste disposal and pollution clearance	12 555	9 196	2 459	762	138
Building industry	392 624	356 320	33 163	2 903	238
Trade, maintenance and repair of vehicles	670 272	608 929	51 390	8 382	1 571
Transportation and sorage	121 962	103 043	15 274	3 105	540
Hotel and restaurant industry	248 900	233 294	13 697	1 723	186
Information und communication	130 758	119 629	8 492	2 216	421
Financial and insurance services	70 151	66 205	1 937	1 239	770
Real state and movable properties	324 562	320 869	3 159	471	63
Freelance, scietific and technical service	515 188	487 793	23 563	3 264	568
Other scientific services	203 354	183 069	13 982	5 060	1 243
Education	76 566	63 173	11 233	1 785	375
Health care and sozial service	237 659	200 670	27 197	7 684	2 108
Art, entertainment and recovery	104 852	101 162	3 025	561	104
Other services	238 398	225 864	10 377	1 836	321
Overall	3 663 432	3 329 245	264 404	56 903	12 880

2. *What is the (estimated) total energy use of the industrial sector in your country? (BMWI)*

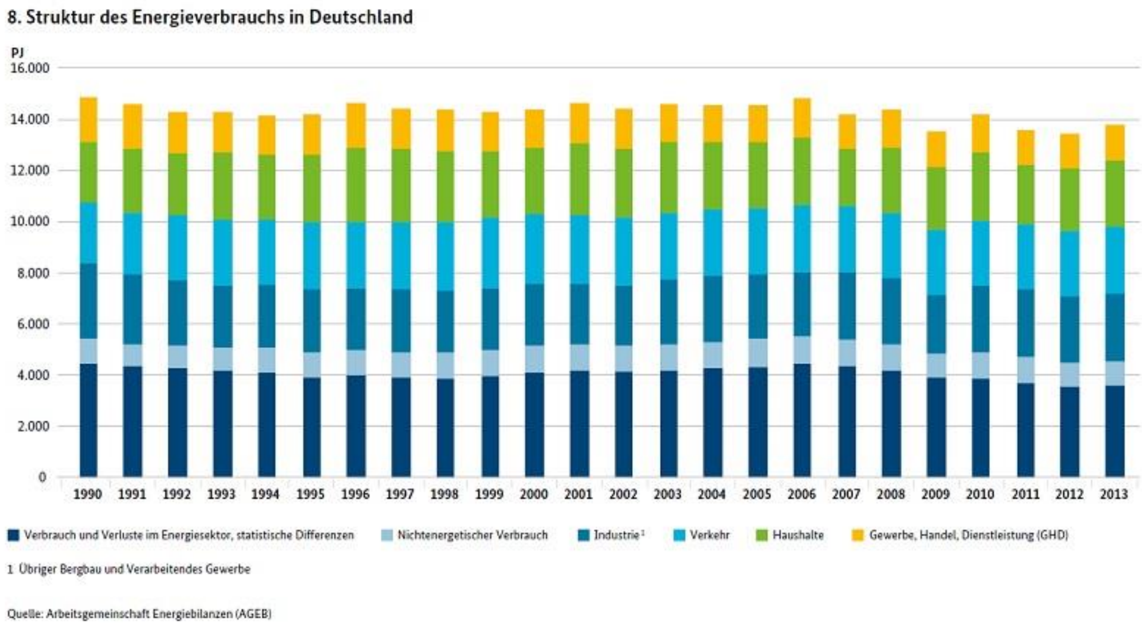


Diagram 1: Energy consumption in the different sectors of the German industry

Visit also: http://www.ag-energiebilanzen.de/#energieflussbild-2013-pj_kurz_20140814

Approximately 2640 PJ final energy consumption in 2013.

3. Give a short description of the type of industrial sectors active in your country.

TJ	Mineral oil				Gas			Electricity	long-distance heat	Coal	Renewable	Other	Overall
	Overall	HEL	HS	Rest	Overall	Natural gas	Rest						
End energy consumption	3253221	750430	23555	2479236	2317360	2122750	194610	1869412	439662	435674	593917	88675	8997921
Stone and mineral industry	1274	942	64	268	4745	4601	144	6708	286	2523	257	0	15793
Food and Tabak	13861	12204	1656	1	113136	112447	689	62923	8571	9397	2230	599	210717
Paper	2561	2291	266	4	83878	83510	368	74164	26303	15094	31888	999	234887
Basic chemical industry	5272	1028	3550	694	187472	174867	12605	157067	68267	11756	9222	50924	489980
Rest of the chemical industry	6729	2569	3873	287	29216	27804	1412	26633	20966	4037	1154	805	89540
Rubber and Plastic	4131	3897	233	1	21234	20990	244	50365	5042	374	345	63	81554
Glass and ceramics	6068	771	5293	4	64033	63742	291	18329	250	180	1581	977	91418
Processing of stone and minerals	15468	7494	1680	6294	45934	45171	763	27835	371	62160	12064	33950	197782
Metall production	12921	398	5309	7214	185172	81600	103572	77149	1877	247052	107	0	524278
NE-Metals, foundries	3745	1713	187	1845	41610	39069	2541	62436	785	12399	11	277	121263
Metal processing	5583	5567	2	14	52077	50371	1706	56751	2579	297	760	21	118068
Maschinery production	10205	9849	44	312	24318	23632	686	40091	5188	136	480	8	80426
Auto industry	2237	2227	0	10	40677	38705	1972	64907	13554	659	326	1	122361
Other industrial sectors	8148	6859	1242	47	46735	46227	508	87381	15456	378	62325	51	220474
Overall industrial sector	98203	57809	23399	16995	940237	812735	127502	812739	169495	366442	122750	88675	2598541

Installations

1. *How many steam boilers are in operation in your country and what is the installed capacity? (Studie für die Arbeitsgemeinschaft Energiebilanze e.V. (AGEB))*

The number of steam boilers cannot be determined due to research limits. However it can be determined how much energy was consumed through process heat, hot water and room heating and with them can be calculated how much steam was used from the different energy sources.

Table 3: End-used and primary energy consumption of process heat in the German industry

End Energy (TWh)*	Room Heating	Process Heat		
		Hot Water	Steam	Other
Heating Oil	6,3	0,5	11,9	7,1
Natural Gas (fossil)	36,9	3,5	78,0	139,9
Electricity	0,9	0,8	18,1	22,3
coal (mix)	2,3	0,2	5,0	94,2
All	**46,4**	**5,0**	**113,0**	**263,6**

Primary Energy (TWh)*	PEF	Room Heating	Process Heat		
			Hot Water	Steam	Other
Heating Oil	1,1	6,9	0,6	13,0	7,8
Natural Gas (fossil)	1,1	40,6	3,8	85,8	153,9
Electricity	2,6	2,4	2,1	47,1	58,1
coal (mix)	1,1	2,6	0,2	5,5	103,7

All	0	52,4	6,7	151,4	323,4

In this case, renewable, biomass and distant heat were not included. The total energy consumption for steam production in the industrial sector in Germany in 2012 was 151,4 TWh primary energy consumption.

2. *Can you specify in type of boilers (water tube boilers, high speed steam raising, fire tube boilers…)?*

It can't be specified due to limited research sources.

3. *Can you specify in fuel type (gas, oil, electric, biomass, etc.)? (Anwendungsbilanzen für die Endenergiesektoren in Deutschland in den Jahren 2011 und 2012 – AGEB – 2014)*

Table 4: End-used energy consumption of the German industry for the different energy sources and their area of application

Energy source	Room heating	Hot water	Other Process heat	Overall heat	Cold	Mechanical energy	IKT	Lightning	EEV
Mineral oil	22,6	1,9	68,2	92,7	0	5,5			98,2
H'oil - EL	20,6	1,9	35,2	57,8	0	0			57,8
H'oil - S	1,9	0	21,5	23,4	0	0			23,4
Rest	0	0	11,5	11,5	0	5,5			17
Gas (fossil)	132,8	12,5	784,5	929,8	0	10,5			940,2
Natural gas	0	12,5	657	802,2	0	10,5			812,7
Rest	3,3	0	127,5	127,5	0	0			127,5
Electricity	29,7	2,9	145,6	151,8	36,2	552	33,3	39,4	812,7
Long-distanc	8,4	2,8	137	169,5	0	0			169,5
Coal	29	0,8	357,2	366,4	0	0			366,4
Renewable	2,2	2,7	91,1	122,8	0	0			122,8
Other		0,2	86,3	88,7	0	0			88,7
Total	227,9	23,9	1669,8	1921,6	36,2	568	33,3	39,4	2598,5
%-fraction	9%	1%	64%	74%	1%	22%	1%	2%	100,00%

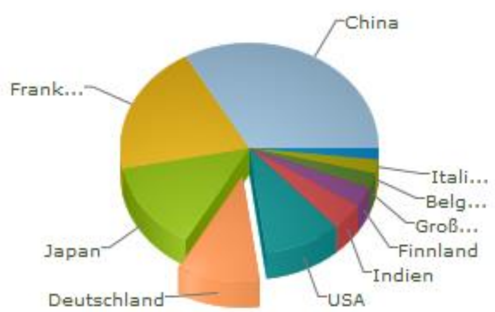
4. *Can you specify in life time of the steam boilers (<10 years, between 10 and 20, >20 years)*

It can't be specified due to limited research sources.

(The life time of thermal-process equipment for middle-sized companies can reach values until 30 years (Energieeffizienz in der Industrie - Markus Blesl; Alois Kessler – Springer Verlag 2013))

Sales figures and developing trends

1. *How many steam boilers are being newly installed on a yearly basis (new or replacements)?(http://www.factfish.com/de/statistikland/deutschland/2813%3A%20dampferzeuger%2C%20produktion)*



A number for the newly installed steam boilers is very difficult to calculate. However the number of steam boilers that are being produce can be approximated through historical assumptions. Germany produced in

2008 approximately 10 % of the global steam boiler production, equivalent to 6.871.501.057 US $; in 2007 5.934.543.464 US $.

Diagram 2: Top 10 Country Diagramm for steam boiler produktion in US Dollar

2. *Is the amount of steam boilers growing, stable or shrinking? (Historic developments)*

We assume, due to the globalization and industrial growth in other countries with lower production cost, that these values are lower in the present days. These are only assumptions and are not scientific facts.

Energy use and potential

1. *What is the total energy use for industrial steam production in your country (PJ)? (Struktur des Energieverbrauches in Deutschland – BMWi 2013); (Energieeffizienz-Potentiale und Umsetzungshemmnisse im Bereich Industrie – Siemens 2013)*

For steam and hot water production the value of the total energy use is assumed to amount approximately 30% of the energy consumption for process heat (dena Factsheet Energieeffizienz Wärmeversorgung). AG Energiebilanzen indicates a final Energy Consumption in the industry of approx. 1650 PJ/a not including room heating and hot water. Therefor total final energy use for industrial steam generation can be estimated to be around 500 PJ/year in German industries.

2. *What is the percentage of total industrial energy use? (Struktur des Energieverbrauches in Deutschland – BMWi 2013)*

Total final energy use in industries is around 2600 PJ/year. 500/2600 = approximately 20%

3. *Is there any information of savings potential through: (Energieeffizienz-Potentiale und Umsetzungshemmnisse im Bereich Industrie – Siemens 2013)*
   a. *Studies,*
   b. *Estimations,*
   c. *Investigations (on-site)*
   d. *…*

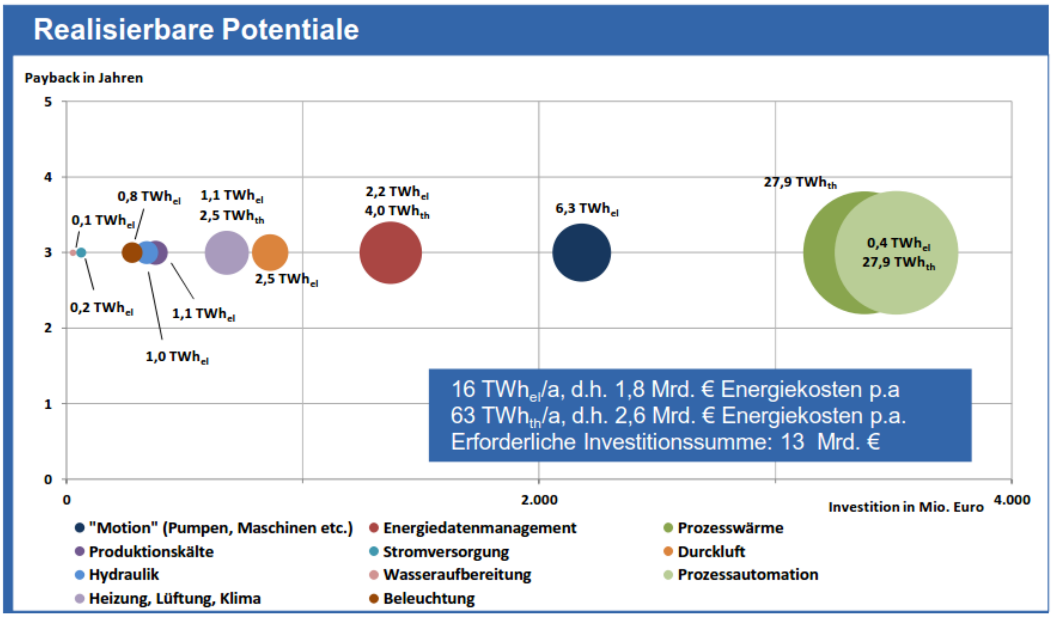


Diagram 3: Energy savings potential in the different industrial tasks in Germany

4. *Based on the above what is the estimated saving potential country wide (in % and (PJ))?*

A total of 79 TWh per year could be saved only with the implementation of technologies with lower Payback-values than 3 years. Consequently, an approximated value of 3 % of the total end-used energy consumption could be saved through energy efficiency measures in all sectors.

5. *Based on the above in what process(es) is/are the highest impact (in % and (P)J) being expected? (Deutschland kann mehr Energieeffizienz – DENA 2012)*

Highest impact and saving potential are connected to process heat, “motion”-technologies (pump, ventilation, etc.) and compressed air technologies. In the case of process heat with an end-used energy consumption of 1355,5 PJ, 100,44 PJ (27,9 TWh_{th}) could be saved by these measures. Assuming that 30% of the process heat energy consumption occurs due to steam production, 30,132 PJ would be save in the steam production process. This represents the 7,41 % of the end-used energy consumption for steam production and 2,22 % of the total end-used energy consumption for process heat of the German industry.

6. *Based on the above in what sector(s) is/are the highest impact (in % and (P)J) being expected? (Energieeffizienz-Potentiale und Umsetzungshemmnisse im Bereich Industrie – Siemens 2013)*

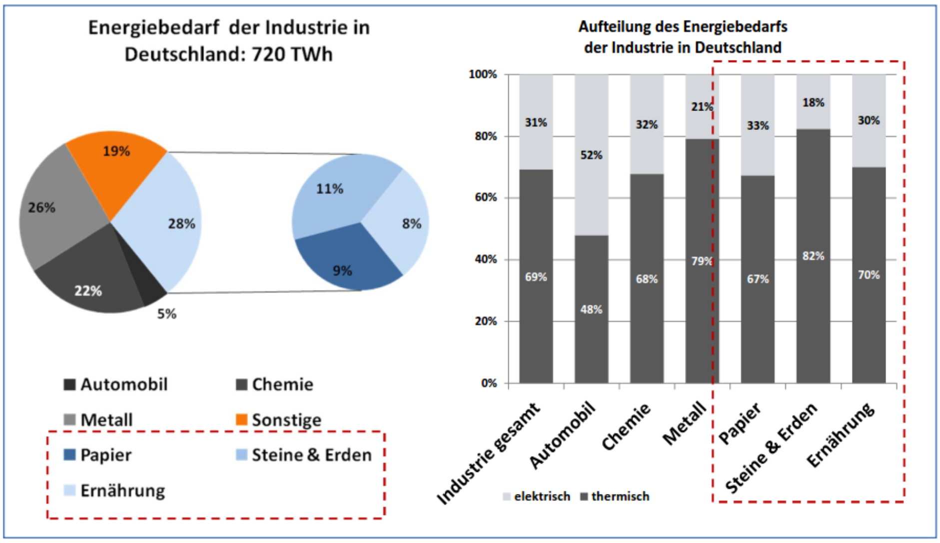


Diagram 4: Electrical and thermal energy consumption in the German industrial sectors

It is difficult to estimate the values of the energy savings potential depending on the sector, because there is no knowledge about the used technologies. Therefore it can only be analyzed the total amount of electrical and thermal energy usage in the different sector and assumed a possible behavior of the energy consumption. As seen in the diagram 4, sectors like metal, food and stone and mineral industries includes large number of thermal energy consumption, so that energy efficiency measures in the thermal field causes big impact in the total energy behavior. Especially by the metal industry, where electric metal furnaces are used for steel recycling, is consumed a large amount of electricity for heating purposes.

The impact of the energy efficiency measures depends strongly of the implemented technologies and the individual industrial parameters and should be calculated for each condition individually.

7. *What are the most promising steam saving measures that (still) can be taken? (Energieeffizienz in kleinen und mittleren Unternehmen – Initiative EnergieEffizienz – DENA 2013)*
   a. Heat recovery (exhaust, blowdown, condensate return)
   b. Operation (operation pressure, stand still, idle mode (no demand))
   c. Control (automated blow down, exhaust oxygen,…)
   d. Distribution (steam traps, control and design of heat exchangers,…)
   e. …

By the Process heat category are the most promising heat savings measures, which contain also some of the steam savings measures.

According to a publication of the DENA (Deutsche Energie-Agentur GmbH) the most promising measures to improve the energy efficiency in the German industry are:

- Building (80% saving potential): heat and cold supply, damping of walls, windows and glazed doors, etc.
- Information technologies (75% saving potential): heat loss of data processing centers, energy efficient use behavior, etc.

- Illumination (70% saving potential): usage of daylight, use of energy efficient lamps with good light irradiation, use behavior, etc.
- Compressed air (50% saving potential): heat recovery, type of compressor, inspection of quality of the pressurized air, etc.
- Pump (30% saving potential): right dimension of the pump depending on the actual demand, high efficient pump gear, etc.
- Process heat (30% saving potential): minimization of heat demand and loss, heat recovery technologies, variable combustion technology, heat reservoir for stabilized the heat supply, etc.
- Room ventilation (25% saving potential): controllable volume flow rate depending on the actual demand, high efficiency technologies, heat recovery, etc.

In accordance with this numbers and the descriptions of the different categories, process heat, especially heat recovery, contains a high value in relation to energy efficiency and saving potential.

Sectors and processes (main industrial users)

1. *How is the energy use distributed over the specific industrial sectors (pulp and paper, chemistry, food processing, wood processing, textile processing…)? (Anwendungsbilanzen für die Endenergiesektoren in Deutschland in den Jahren 2011 und 2012 – AGEB – 2014)*

Table 5: End-used energy in the different industrial sector depending on the energy source

TJ	Mineral oil				Gas			Electricity	long-distance heat	Coal	Renewable	Other	Overall
	Overall	HEL	HS	Rest	Overall	Natural gas	Rest						
End energy consumption	3253221	750430	23555	2479236	2317360	2122750	194610	1869412	439662	435674	593917	88675	8997921
Stone and mineral industry	1274	942	64	268	4745	4601	144	6708	286	2523	257	0	15793
Food and Tabak	13861	12204	1656	1	113136	112447	689	62923	8571	9397	2230	599	210717
Paper	2561	2291	266	4	83878	83510	368	74164	26303	15094	31888	999	234887
Basic chemical industry	5272	1028	3550	694	187472	174867	12605	157067	68267	11756	9222	50924	489980
Rest of the chemical industry	6729	2569	3873	287	29216	27804	1412	26633	20966	4037	1154	805	89540
Rubber and Plastic	4131	3897	233	1	21234	20990	244	50365	5042	374	345	63	81554
Glass and ceramics	6068	771	5293	4	64033	63742	291	18329	250	180	1581	977	91418
Processing of stone and minerals	15468	7494	1680	6294	45934	45171	763	27835	371	62160	12064	33950	197782
Metall production	12921	398	5309	7214	185172	81600	103572	77149	1877	247052	107	0	524278
NE-Metals, foundries	3745	1713	187	1845	41610	39069	2541	62436	785	12399	11	277	121263
Metal processing	5583	5567	2	14	52077	50371	1706	56751	2579	297	760	21	118068
Maschinery production	10205	9849	44	312	24318	23632	686	40091	5188	136	480	8	80426
Auto industry	2237	2227	0	10	40677	38705	1972	64907	13554	659	326	1	122361
Other industrial sectors	8148	6859	1242	47	46735	46227	508	87381	15456	378	62325	51	220474
Overall industrial sector	98203	57809	23399	16995	940237	812735	127502	812739	169495	366442	122750	88675	2598541

Source: AG Energiebilanzen

2. *How is the energy use distributed over the specific processes (drying, evaporation, distillation, heating/boiling)?*

Table 6: End-used energy consumption of the German industry for the different energy sources and their area of application

Energy source	Room heating	Hot water	Other Process heat	Overall heat	Cold	Mechanical energy	IKT	Lightning	EEV
Mineral oil	22,6	1,9	68,2	92,7	0	5,5			98,2
H'oil - EL	20,6	1,9	35,2	57,8	0	0			57,8
H'oil - S	1,9	0	21,5	23,4	0	0			23,4
Rest	0	0	11,5	11,5	0	5,5			17
Gas (fossil)	132,8	12,5	784,5	929,8	0	10,5			940,2
Natural gas	0	12,5	657	802,2	0	10,5			812,7
Rest	3,3	0	127,5	127,5	0	0			127,5
Electricity	29,7	2,9	145,6	151,8	36,2	552	33,3	39,4	812,7
Long-distanc	8,4	2,8	137	169,5	0	0			169,5
Coal	29	0,8	357,2	366,4	0	0			366,4
Renewable	2,2	2,7	91,1	122,8	0	0			122,8
Other		0,2	86,3	88,7	0	0			88,7
Total	227,9	23,9	1669,8	1921,6	36,2	568	33,3	39,4	2598,5
%-fraction	9%	1%	64%	74%	1%	22%	1%	2%	100,00%

Source: AG Energiebilanzen

In this case it could not be determined the steam specific processes.

3. *How are enterprises organized over sectors, are there specific sector organizations in place?*
   a. *What is their main objective?*
   b. *How do they contribute to the subject of increasing energy efficiency at enterprises?*

For example, the "Bundesverband der Deutschen Industrie e.V (BDI)" and the "BDEW Bundesverband der Energie- und Wasserwirtschaft e.V." deal with energy efficiency themes, among others, and try to sensitize and inform industry about energy efficiency measures, status quo and savings potential.

Legislation and regulation (steam and energy efficiency)

1. *What national legislation and/or regulation does apply when it comes to steam production and steam use? (emissions, maintenance, pressure equipment directives,..). Please specify (name, main obligations, enforcement and checking (audits)(Technische Regeln für Dampfkessel Prüfung - Prüfung von Dampfkesselanlagen Allgemeines (TRD 500); TRBS 1000 – TUV Süd)(Energiesteuergesetz (EnergieStG))*

The manufacturing process of a steam boiler is regulated by the European Pressure Equipment Directive.

With the „Dampfkesselverodnung" (today "Betriebssicherheitsverordnung (BetrSichV)") and the „Technischen Regeln für Dampfkessel (TRD)" of the „Bundesministerium für Arbeit und Sozialordnung", the manufacture of steam boilers and steam production and use are regulated according to the actual technical situation. Before the initial operation of the steam boiler, an examination corresponded to "§ 14 BetrSichV" need to be done.

In addition, an energy tax for the use of an specific energy source has to be paid.

2. *What national legislation and/or regulation do apply when it comes to the efficient use of energy? ,..). Please specify (name, main obligations, enforcement and checking (audits)*

In September 2010, the German Government adopted a new Energy Concept. The aim was to develop an overall strategy for the period up to 2050. Among the nine fields of action, energy efficiency was seen as a key issue, since the Energy Concept is based on a dual strategy: reduction of energy demand by significantly increasing energy efficiency and meeting the energy demand mainly by renewable energies.

With regard to energy efficiency, the Energy Concept includes ambitious targets. At the level of the whole economy, primary energy consumption shall be reduced by 20% until 2020 and by 50% until 2050. Electricity consumption is planned to be cut by 10 % until 2020 and by 25 % until 2050 (all compared with 2008). In addition, the following sectoral energy efficiency targets have been set: for buildings a doubling of the building renovation rate from about 1 % to 2 % and a reduction of the heating requirements by 20% until 2020 and by 2050 a reduction of the primary energy demand by 80% for transport a reduction in final consumption by about 10% by 2020 and 40% by 2050 (compared with 2005).

3. *Are there any (national) standards for (efficient) steam boiler operation and design?*

The standards for design, operation, construction and examination of a steam boiler and its component are determined by the TRD (“Technische Regel für Dampfkessel”).

4. *Are there any financial instruments and or programs from national and/or local governments to support the rational use of energy and/or steam (subsidies, fiscal and financial instruments, bank guarantees, revolving funds, green loans…)*

For the first time, a special energy efficiency fund was established. Financing for the existing National Climate Initiative will be significantly increased. Both initiatives shall initiate important efficiency measures at all levels - municipalities, industry, SMEs and consumers. With regard to product labeling and standards, Germany is advocating ambitious standards at EU level and a transparent labeling for cars, products and buildings. In order to save electricity, the advisory service for private consumers was considerably extended, esp. for poor households. In industry, a wider spread of energy management systems and energy audits is supported in order to help industry to better identify and tap its efficiency potential. In the course of reorganization of the eco-tax relief to energy-intensive companies, this requirement is to be linked to the operation of energy management systems in accordance with international standards (EN 16001, ISO 50001) from 2013. In addition, successful financial support programs especially for SMEs shall be extended, as e.g. the special energy efficiency fund for SMEs.

Check and audits

1. *Are steam boilers checked on a regular basis and if yes on what frequencies?* (*Technische Regeln für Betriebssicherheit (TRBS 1000 und 2000 – TUV Süd); Technische Regeln für Dampfkessel Allgemeines Aufbau und Anwendung der TRD (TRD 001))*

During the operation of steam production, the parameters of the process are continuously being monitored. Depending on the different factors of operation, the art of steam boiler and its parameters, the last check and audit and the recommendation of the manufacturer, the period of time between audit and checks are established. Nevertheless a periodical check of the steam boiler has been established in the "Dampfkesselverodnung" as below:

- Internal Examination every third year
  - Cladding and surfaces
- External Examination every year
  - Pipeline system
  - Safety-relevant parts
  - Firing system
- Water pressure examination every ninth year

For more information visit the website:

http://www.netinform.de/Vorschriften/TRBS/TRBS_1201.htm#2.4

http://www.arbeitssicherheit.de/de/html/library/document/251914,7

http://www.umwelt-online.de/recht/anlasi/gsg/vo/dampfkv/dpfk_ges.htm

2. *If a regular check is being performed what is being checked on?*
   a. *Emission numbers (O2, NOx…)*
   b. *Boiler water quality and composition*
   c. *Integrity of pressure equipment*
   d. *Energy saving opportunities*
   e. *Steam traps*
   f. *…*

An overview and detailed description of the examinations depending on the type and parameter of the steam boiler is shown in the following link:

http://www.arbeitssicherheit.de/de/html/library/document/251948,3

Also see Answer number 1.

3. *Can you indicate specific steam auditing tools, practices and or methodologies? Please specify using the A. Template for Tools and Methodologies.*

Please visit the following link:

http://www.netinform.de/Vorschriften/TRBS/TRBS.htm

The already existing Energy Audit Scheme of KfW should be adapted to the requirements of EN 16247 in order to ensure a harmonized audit methodology.

4. *Can you indicate specific information (guide books, websites, factsheets, trainings…) on steam use and steam efficiency? Please specify using the B. Template for Information Sources and Training Materials.*

For example the "Initiative EnergieEffizienz" publishes information and guidelines about heat supply and processes in the Industry, among other topics.

Steam Experts and Expertise

1. *How is the conservation and education/training of steam expertise 'organized' in your country?*
   a. *Are there expert platforms, associations, website, or others? Please specify.*

Yes, for example the "Initiative EnergieEffizienz" of the DENA (Deutsche Energie-Agentur GmbH), The National Action Plan on Energy Efficiency (NAPE) and the Energy Efficiency Platform, launched by the German federal government, DENEFF (Deutsche Unternehmensinitiative Energieeffizienz), Fraunhofer ISI, etc.
Visit also:
http://www.bmwi.de/EN/Topics/Energy/energy-efficiency.html
http://www.deneff.org/
http://www.isi.fraunhofer.de/isi-de/index.php

   b. *Are there dedicated educations (vocational, university…), trainings, courses and/or workshops available in your country? Please specify type and (public and/or commercial) organization(s) where education, trainings etc. is available.*

Yes. For example the DENEFF and the Fraunhofer ISI organized a workshop named "Weltmeister der Energieeffizienz? Wie gut ist Deutschland wirklich?" in 2015.

2. *Can you give an indication of the level of steam expertise within industrial enterprises using steam? Please specify.*
   a. *Do enterprises have dedicated steam experts? (Kesselwärter – Gibt es die eigentlich noch? – Thomas Prager – TÜV Rheinland Industrie Service GmbH 2012)*

According to the "BetrSichV" the companies are responsible of the operation and maintenance of the steam boilers, but it is not specified how. So, the enterprises that operate a steam boiler should have an operator with the required qualifications. Therefore an external expertise (boiler attendant) should do the proper maintenance of the steam boiler or an operator of the company should complete a training as a boiler attendant. This is a requirement of the "Betriebssicherheitsverordnung (BetrSichV)"

b. *Who is responsible for the steam installation in the industrial enterprises and what is his/her level of expertise in steam production and use for industrial purposes? (BetrSichV- Dampfkesselanlagen)*

The installation of the steam boiler is done by the enterprise itself.

c. *Is steam expertise and application outsourced? (Steam equipment suppliers are responsible for steam supply, operation and maintenance) (BetrSichV-Dampfkesselanlagen)*

The enterprise is responsible of the proper production of steam and operation of the steam boiler. Therefore they can decide if the steam boilers are operated and maintain by an external company or intern.

d. *Is steam expertise 'hired' via energy auditors or consultants? (TÜV Süd – Dampf- und Drucktechnik)*

A steam expertise can be gained via energy auditors and consultants. For example TÜV Süd offers consultancy from production and Installation of the steam boiler until its operative tasks.

e. *Are there other means used by enterprises to maintain a proper level of steam expertise? (ZÜS-Lehrgang zum geprüften Kesselwärter befähigt zu Einsatz an alle Dampfkessel – Thomas Prager – TÜV Rheinland Industrie Service GmbH 2012)*

The "Zugelassenen Überwachungsstellen (ZÜS)" offers training for workers as a boiler attendant (Kesselwärter).

3. *Can you indicate specific steam experts (persons) in your country? Please specify using the C. Template for Steam Experts. Project Deliverable (2.3)*

We suggest:

General information		
Name:	Christopher Soldwedel	
Organisation:	eproplan	Language/s: German, English
Country:	Germany	Region: Stuttgart, Baden-Württemberg
Years of Experience:	>10 years	Curriculum Vitae: www.eproplan.de
Qualification/ Certification:	Director Energy Management, Engineer	
Training Skills:	Not known	

Relevant Memberships:	• VIK Verband der industriellen Kraftwirtschaft e. V., Essen
	  ◦ Arbeitskreis Energieeffizienz
	  ◦ Arbeitskreis Kraft-Wärme-Kopplung (KWK)
	• Ingenieurkammer Baden-Württemberg, Stuttgart
	• VBI Verband Beratender Ingenieure, Berlin
	• Arbeitsgemeinschaft Energieeffizienter Netzwerkee. V. AGEEN
	• Modell Hohenlohe - Netzwerk betrieblicher Umweltschutz und nachhaltiges Wirtschaften e. V., Waldenburg
	• Umweltkompetenzzentrum Rhein-Neckar e. V. UKOM	

	• Förderkreis Umweltschutz Unterfranken (FUU) e.V. • Industrie- und Handelskammer Baden-Württemberg, Region Stuttgart	
References:	Eproplan is one of the major companies for facility planning and optimization in Germany. Region around Stuttgart has a lot of industrial companies Reference List on www.eproplan.de	
Contacts		
E-mail:	c.soldwedel@eproplan.de	Telephone: +49 (0)711-7 69 88-37
Notified[12]:	Yes, eproplan shall be subcontractor for Germany	

Key players in Industrial Steam (Force Field Analysis)

1. *Who are the key players in the field of steam use, technology (transfer) and expertise?*

a. *Industrial enterprises:* Bosch, Certus, Balsmann, etc.

b. *Equipment suppliers:* Gestra AG (Sell the required equipment)

c. *Technology suppliers:* Balsmann, Bosch, Certus, Stöckel (Sell the steam boilers and maximize the energy efficiency of those)

d. *Contractors:* Techem Energy Contracting, GASAG Contracting

e. *Consultants:* Eproplan

f. *Energy auditors:* In Germany most of them work independently. Key actors have in common, that they have to be accredited by the KfW and listed in the KfW Energy Auditor Database. EMAS accredited environment verifiers also play a role in energy audits (eligible to hand out ISO 50001 certificates) (Identification of Energy Efficiency potentials)

g. *Sector organizations:*
DIHK, VDMA (Spreading information to their members and representing their interests. Often they organizes qualification seminars for their member´s employees)

h. *Expert platforms: BMWi* "Platform Energy Efficiency", energieeffizienz-online (DENA) (Information and communication of knowledge in the field)

i. *Other*

Energy Auditing Practices

[12] Is the expert notified that he will be contacted by the Steam Up consortium to become part of the expert network and/or to give trainings?

1. *Are enterprises regularly audited on energy use and efficiency? (Energiemanagementsysteme in der Praxis – adelphi research GmbH - Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) & Umweltbundesamt (UBA))(RICHTLINIE 2012/27/EU)(ISO 50001)(Energiemanagementsysteme Auditierung und Zertifizierung - Gerhard Gensicke, Umweltgutachter - GfBU)*

Energy audits in SMEs are supported by subsidies (80% of the audits costs) in course of *Program "Energieberatung Mittelstand" of the "Bundesamt für Wirtschaft und Ausfuhrkontrolle BAFA.* The middle-size enterprises are not obligated to do energy audits. However in Germany there are more than 50.000 companies that already implemented the quality management norm DIN EN ISO 9001 and more than 6.000 the environmental management norm DIN EN ISO 14001. In 2013 were approx. 1539 companies certificated by ISO 50001.

2. *What are the main reasons for an enterprise to do an energy audit?*
   a. *<u>Legal obligations:</u> there are no legal obligations on energy efficiency, nevertheless an ISO 50001 Certification or an EMAS-certification is needed to avoid the energy taxes and the EEG apportionment.*
   b. *<u>Subsidized by government:</u>* Already mentioned p*rogram "Energieberatung Mittelstand" of the "Bundesamt für Wirtschaft und Ausfuhrkontrolle BAFA*
   c. *<u>To be able to cut energy costs:</u> Reduction of marginal cost and total cost*
   d. *<u>As part of their energy management system:</u> sustainable economic system*
   e. *<u>As part of their sustainability policy:</u> Environmentally friendly*
   f. *Other*

3. *Is there a national legal or regulatory framework to stimulate the rationale use of energy and how is energy audits part of this? Please specify (name, main obligations, enforcement and checking (audits)? ("Bundesministerium für Wirtschaft und Energie (BMWi)")(„Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA) – Bundestelle für Energieeffizienz (BfEE)")*

The "Bundesministerium für Wirtschaft und Energie (BMWi)" works as an informative platform on the energy field and stimulate the rational use of energy and energy efficiency in several sector. Not only are the middle-sized enterprises benefited, also household, suppliers and experts. The institution "Bundesstelle für Energieeffizienz (BfEE)" is responsible of the implementation, regulation and monitoring of the "Energieeffizienz-RL 2012/27/EU" of the EED in Germany.

4. *Are there, apart from the EED obligations, national or local, obligations for enterprises to perform energy audits? (Energiemanagementsysteme Auditierung und Zertifizierung - Gerhard Gensicke, Umweltgutachter - GfBU)*

Germany offers tax benefits for energy intensive industries (specific NACE-Codes) resulting in lower effective energy prices. In order to further profit from that reductions, SMEs have to carry out Energy Audits according to EN 16247, large companies have to be certified according to ISO 50001.

5. *What type of organizations has the obligations to perform energy audits? (SME's, non-SME's, based on energy use (> x PJ), other) (RICHTLINIE 2012/27/EU)*

Little- and middle-sized are not obligated to perform energy audits. If the enterprise performs one of the European certificated energy (ISO 50001) or environmental management norms (EMAS), an energy audit is not required anymore.

6. *How are enterprises, without the legal obligations to perform an audit, stimulated to perform audits? (see EED Article 8)(EnergieStG)(Energiemanagementsysteme Auditierung und Zertifizierung - Gerhard Gensicke, Umweltgutachter - GfBU)(BMWi)*

The national government and the regional governments provide guides on Energy Efficiency and Energy management free of charge.

Also there are tax incentives for companies of specific sectors who implement ISO 50001 or EMAS. Alternative for the middle-size enterprises is the certification DIN EN 16247-1.

The above mentioned BAFA program

7. *Are there any support programs from national or local government to stimulate the rational use of energy, including the execution of audits?*

For example, the NAPE of BMWi is one of them. (Nationaler Aktionsplan Energieeffizienz)

The above mentioned BAFA program

8. *Are audit reports registered from governmental side or others?*

They are being registered by BAFA.

9. *How are audit results being followed up (implementation guiding, monitoring)? („Bundesamt für Wirtschaft und Ausfuhrkontrolle – Bundestelle für Energieeffizienz (BfEE)“)*

The “Arbeitsgemeinschaft Energiebilanzen (AGEB)” provides year to year data of Energy Efficiency progress in Industry and non-Industry sectors on basis of company surveys carried out e.g. by Fraunhofer ISI. The BfEE monitor also the energy efficiency in Germany.

10. *Based on the above can you give figures (or an indication) on the implementation rate of identified energy efficiency measures from the audits? Please comment on the (high or low level of implementations: what are the main arguments for success or failure? (Evaluation des Förderprogramms „Energieberatung im Mittelstand“ - Institut für Ressourceneffizienz und Energiestrategien GmbH (IREES) & Fraunhofer Institut ISI - 2014)*

From left to right: Lightning, Room Heating and Hot Water, Heat regeneration, air pressure, Ventilation and Climatisation, building, organisational measures, energy management, CHP, process heat, electric drives, regenerative energies, cold, Process technology, Information Telecommunication, energy services

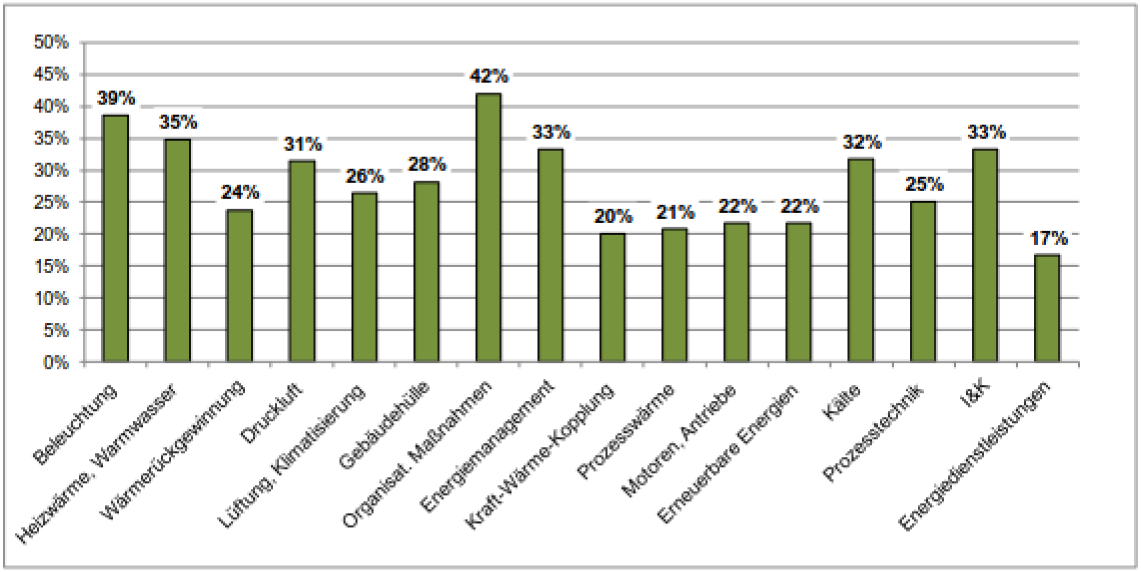


Diagram 5: Fraction of the realized measures

The highest fraction of the realized measures appears on the organization's measures, followed by the categories lighting and room heat and warm water. The lowest implementations measures are in the categories: energies services, cogeneration and process heat.

11. *What is currently hindering the implementation of steam/energy saving measures? Please argument (with facts) and explain (Evaluation des Förderprogramms „Energieberatung im Mittelstand“ - Institut für Ressourceneffizienz und Energiestrategien GmbH (IREES) & Fraunhofer Institut ISI - 2014).*

    Summary following diagram:

    - *High investment cost*
    - *Too long payback period*
    - *Measures is not profitable*
    - *Lack of knowledge*
    - *Lack of time to organize*
    - *Lack of sensitivity for economic effects*

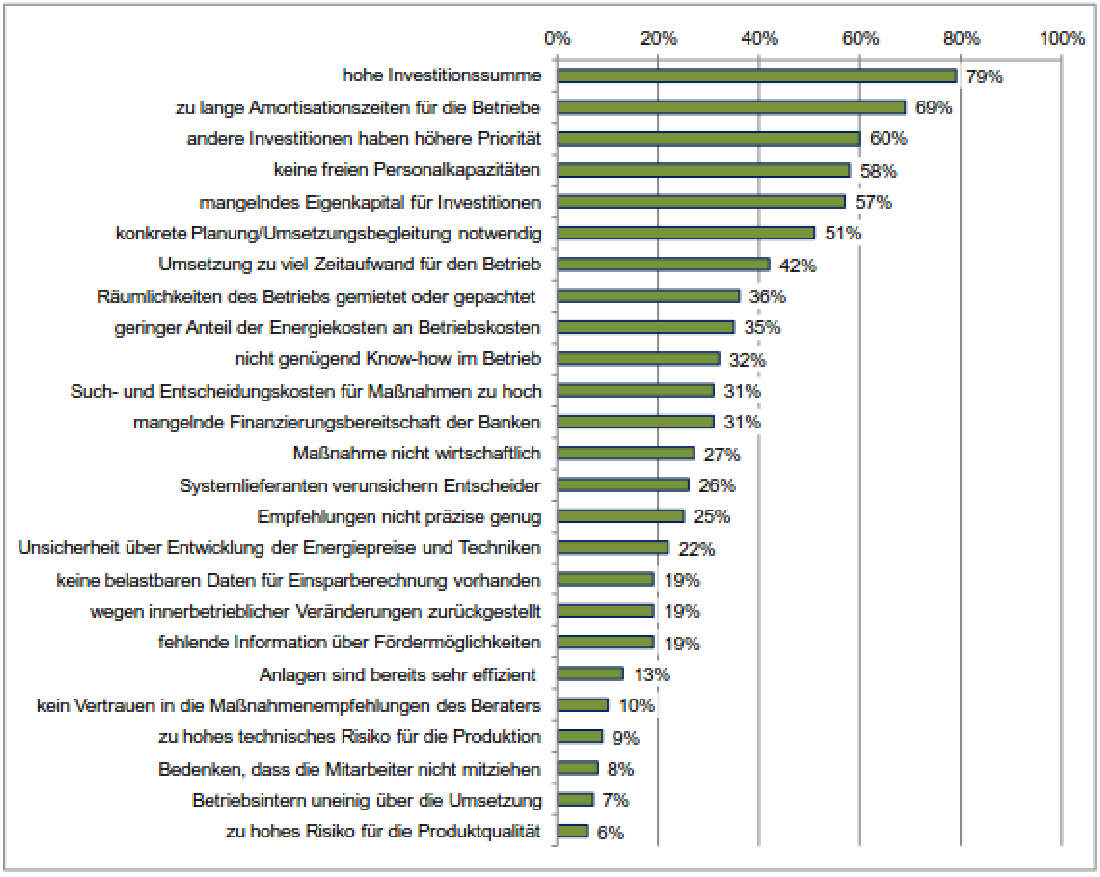


Diagram 6: Obstacle for implementation of the measures

12. *Are there any financial instruments and or programs from national and/or local governments to support the rational use of energy and/or steam (subsidies, fiscal and financial instruments, bank guarantees, revolving funds, green loans…)*

BAFA scheme on energy efficient technologies, KfW scheme for refurbishment of Buildings, various schemes for application of renewable energies incl. EEG, BAFA scheme on combined heat and power generators

13. *Can you indicate specific energy auditing tools, practices and or methodologies? Please specify using the A. Template for Tools and Methodologies.*

In Germany a lot of organizations are accredited according to ISO 50001: 1394 as of 9 Apr 2013. More than in the rest of the world altogether! This probably has to do with the mentioned tax benefits. Tools are e.g. free available guides (e.g. adelphi´s ISO 50001 guide available on the pages of BMU).

14. *Can you indicate specific information (guide books, websites, factsheets, trainings…) on energy auditing? Please specify using the B. Template for Information Sources and Training Materials.*

The DIHK carries out the EUREM program (European Energy Manager) in Germany, a comprehensive qualification scheme for Energy auditors covering the technical and managerial aspects of increasing Energy Efficiency. Furthermore the TÜV-Organizations provide seminars for Energy Auditors and Energy Managers.

Please visit the following link to see the certificated energy management software programs: http://www.bafa.de/bafa/de/energie/energiemanagementsysteme/publikationen/energiemanagementsoftware.pdf

Management Practices

1. *What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?*

ISO 50001, EMAS, ISO 9001, ISO 14001.

2. *Can you indicate the amount of certifications issued on the above mentioned standards?(Energiemanagementsysteme Auditierung und Zertifizierung - Gerhard Gensicke, Umweltgutachter - GfBU)*

In Germany there are more than 50.000 companies that already implemented the quality management norm DIN EN ISO 9001 and more than 6.000 the environmental management norm DIN EN ISO 14001. In 2013 were approx. 1539 companies certificated by ISO 50001.

3. *Are there any other management practices or standards where energy efficiency is addressed or that could accommodate energy efficiency policies in enterprises?*

EN 16247, EN 16231, Eco-Design regulations, DIN V 18599

4. *What financial (risk) assessment tools and methods are generally used in industrial enterprises in your countries to assess investments?*
   a. *NPV (Net Present Value)(Kapitalwert-Methode)*
   b. *IRR (Internal Rate of Return)(Interne Verzinsung)*
   c. *LCC (Life Cycle Costing)*
   d. *TCO (Total Cost of Ownership)*
   e. *SPP (Single Payback Period) (Amortisationszeit-Methode)*
   f. *Other*

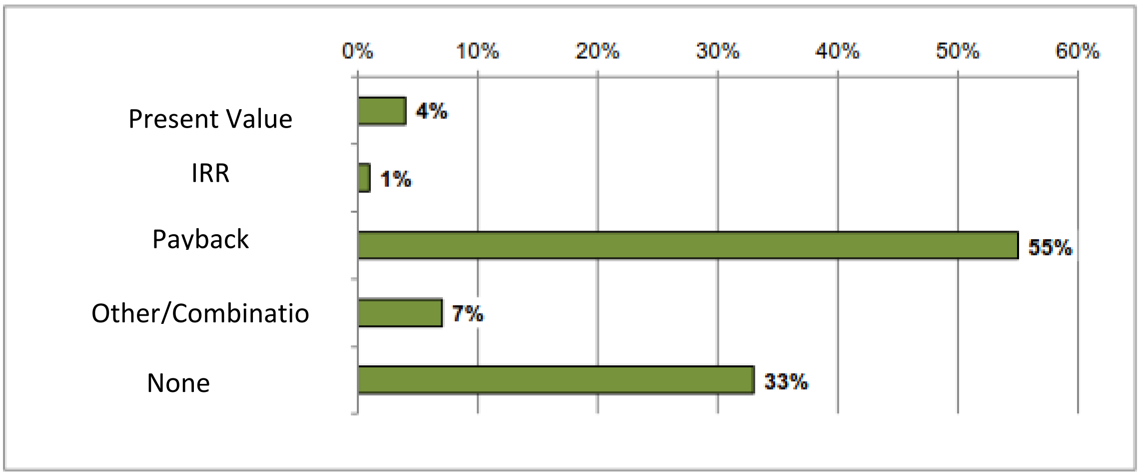


Diagram 7: Financial assessment models used to calculate risk of energy saving measures

5. *How do they influence (negatively or positively) the investment decisions for energy efficiency projects)? Please explain.*

If something is profitable they may realize the measure.

6. *Are you aware of any other (innovative) business models, management practices or financial assessment practices that could accommodate energy efficiency policies in enterprises? Please specify.*

Energy Contracting.

Non Energy Benefits

1. *How are non-energy benefits accounted for when making investment decisions?*

Often not considered

2. *Do you have any good practices available in your country how the inclusion of non-energy benefits in the assessment influenced the investment decision for energy efficiency investments?*

REWE Berlin Falkensee: Green Building. Investment decision was made also because of increase of attractiveness of vending spaced (natural lightning, nice ambient)

Behavior and energy efficiency

1. *Do you have examples from your country on studies, pilots, programs or practices where insights from behavioral science and change management were used to enhance energy efficiency in enterprises? Please specify (publication, report, language,…)*

DEHOGA Energy Efficiency Campaign

The German Hotel and Catering association (DEHOGA) informs Hotels and Restaurants (Energy intensive industry as Energy Costs amount 5-10% of the total turnover) about profitable Energy Efficiency measures through its "Energy Efficiency Campaign". The involvement of the DEHOGA ensures a high credibility, as it represents the interests of the branch, leading to a high acceptance of the campaign that is carried out by adelphi. It consist of

1. DEHOGA Energiekampagne Gastgewerbe: a mostly web-based Information campaign offering understandable Information on energy efficient technology/behavior and a Monitoring and Benchmarking portal
2. DEHOGA Energieberaterkooperation: Regional cooperation with well selected energy auditors in order to ensure high quality audits.
3. DEHOGA Energy Efficiency Networks: Moderated, periodic workshops with 10-15 network participants for exchange of experience between middle sized and larger Hotels in order to jointly realize proposed Measures of carried out energy audits.

4. DEHOGA Umweltcheck: It checks the current level of Energy, Water and Garbage efficiency on behalf of Benchmarking and sustainable purchase of food in order to generate a marketing advantage for high efficient Hotels and Restaurants

2. Can you describe the striking successes and/or failures of these approaches?

These “soft” measures a in general a very cost efficient way to promote Energy Efficiency - but it is hard to measure what the generated savements effects really are in detail

B.5 GREECE

Industrial enterprises in Greece

In Greece, the most developed industrial sectors are textile, food (flour, sugar and dairy products), and chemical (plastic and pharmaceuticals). Additionally, oil refineries in Aspropirgo, Eleusina, Agioi Theodoroi and Thessaloniki play a significant role for the Greek economy. The tobacco industry was very developed but its demand is reduced. Finally, industry of building materials (cement, ceramic, gravel, lime, etc) presents huge development and Greece exports large quantities of cement.

(Source: http://www.livepedia.gr/index.php/%CE%95%CE%BB%CE%BB%CE%AC%CE%B4%CE%B1_/%CE%9F%CE%B9%CE%BA%CE%BF%CE%BD%CE%BF%CE%BC%CE%AF%CE%B1_/%CE%92%CE%B9%CE%BF%CE%BC%CE%B7%CF%87%CE%B1%CE%BD%CE%AF%CE%B1)

According to the Hellenic Statistical Authority (El. Stat.) there are 4 main industrial sectors in Greece:

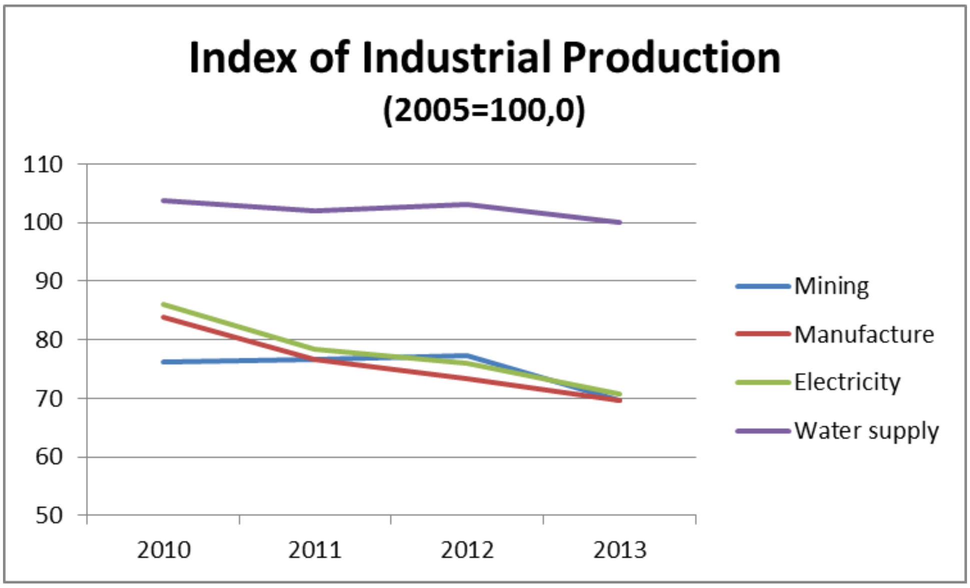
Mining, manufacture, electricity and water supply. Analytically, the industries active in Greece are shown in table 1:

Table 1: Index of industrial production

Index of industrial production (2005=100,0)				
Industrial sectors	**2010**	**2011**	**2012**	**2013**
General index	**84,4**	**77,9**	**75,2**	**72,5**
Mining	**76,2**	**76,7**	**77,2**	**69,6**
Coal and lignite mining				
Oil and gas piping				
Other activities				
Manufacture	**83,8**	**76,6**	**73,4**	**69,6**
Food products	96,7	95,8	92,5	87,9
Beverages	96,3	87,4	80,1	78,4
Tobacco products	74,6	82,4	75,1	77,1
Textile	41,9	32,7	26,2	22,3
Clothes	48,3	36,1	33,6	32,2
Leather & Footwear	50,0	42,2	28,8	28,5
Wood and wood products	60,4	75,5	53,2	40,0

Paper & paper products	94,1	85,7	76,4	78,3
Printing and recorded media	75,7	57,2	45,3	40,8
Oil and carbon derivatives	110,8	94,7	117,7	122,9
Chemicals	84,7	81,0	71,1	72,6
Main pharmaceutical products	153,5	152,9	145,0	164,4
Elastic and plastic products	85,4	78,8	71,5	72,6
Non ferrous metals	59,4	38,2	32,2	31,6
Basic metals	92,6	98,5	92,4	87,2
Manufacture of metal products	79,7	76,2	68,3	59,3
Computers and electronic products	30,6	23,4	21,8	28,6
Electronic equipment	79,1	70,4	66,1	57,8
Machinery & equipment	64,9	59,7	52,9	54,0
Motor vehicles	71,6	49,8	42,9	41,9
Transport equipment	54,8	37,0	21,5	19,3
Furniture	62,9	49,0	34,3	28,1
Other manufacture activities	64,5	55,9	48,8	46,3
Repair and installation of machinery	58,0	57,2	48,9	41,6
Electricity				
Electricity production and supply	**86,0**	**78,4**	**76,0**	**70,8**
Water supply				
Water supply and processing	**103,7**	**102,0**	**103,0**	**100,1**

Source : Hellenic Statistical Authority (El. Stat.),
http://www.statistics.gr/portal/page/portal/ESYE/BUCKET/General/ELLAS_IN_NUMBERS_GR.pdf



Source: Hellenic Statistical Authority (El. Stat.),
http://www.statistics.gr/portal/page/portal/ESYE/BUCKET/General/ELLAS_IN_NUMBERS_GR.pdf

According to the Hellenic National Statistics Agency, the number of manufacture enterprises is shown in the following table:

Table 2: Data for the Greek industry in the manufacture sector

Data for the Greek industry in the manufacture sector Units: EUR million			
	2009	2010	2011
Number of industries	83.565	79.338	74.066
Number of employees	400.934	379.269	338.735

Source : Hellenic Statistical Authority (El. Stat.),
http://www.statistics.gr/portal/page/portal/ESYE/BUCKET/General/ELLAS_IN_NUMBERS_GR.pdf, ppg 22

The final energy consumption for the manufacture is shown in table 3:

Table 3: Final energy consumption for the manufacture

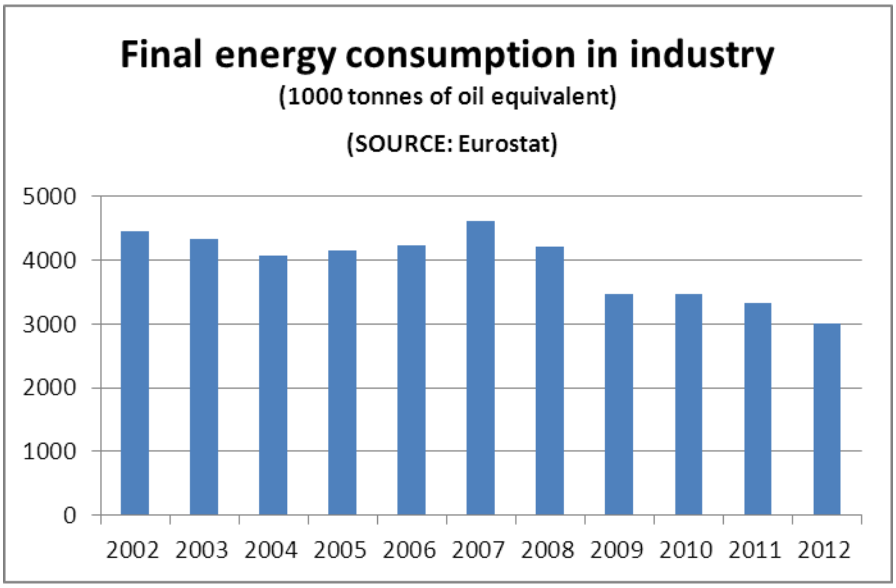
Final energy consumption for the manufacture **Units: 1.000 tonnes of equivalent oil**			
	2010	2011	2012
Greece	19.002,8	18.872,8	17.129,3

Source : Hellenic Statistical Authority (El. Stat.), http://www.statistics.gr/portal/page/portal/ESYE/BUCKET/General/ELLAS_IN_NUMBERS_GR.pdf, ppg 25

Energy consumption and electricity in the industrial sector

Energy consumption in industry is decreasing. Based on statistics by EUROSTAT, until 2008 the final energy consumption in industry represented 20-21% of the total final energy consumption, whereas after 2008 to 2012 this is decreased to 17-18%. This is mainly attributed to the financial crisis. Additionally, based on information by the Hellenic Statistical Authority (El. Stat.) the consumption of electricity consumption in the industrial sector is 12,202,237 kWh for 2012 that is 23.8% of the total electricity consumption in Greece and 15,371,516 kWh for 2007 that is 28% of the total electricity consumption.

Table 4: Final energy consumption in industry for Greece



Source: Hellenic Statistical Authority (El. Stat.)

Table 5: Final energy consumption in Greece (1000 tonnes of oil equivalent),

Final energy consumption in Greece and final energy consumption in Greek industry (1000 tonnes of oil equivalent)											
Years	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Final energy consumption	19639,3	20677,7	20456,3	20955,5	21554,1	22060,3	21378,2	20530,1	19002,8	18872,8	17129,3
Final energy consumption in industry	4445,7	4330,6	4069,9	4160,7	4234,2	4603,9	4211,8	3461	3471,4	3322,5	2998,1
% industry of total economy	0,23	0,21	0,20	0,20	0,20	0,21	0,20	0,17	0,18	0,18	0,18

Source: Hellenic Statistical Authority (El. Stat.)

Until 2007 the industry's final consumption was steadily increased, however, the industry sector was one of the first sectors which sustains the effects of the economic recession in final energy consumption. This fact led to the decrease of final consumption of industry, over the last 5 years. The oil remains the main fuel in industry and the reduction of oil consumption by 4% (1.75 Mtoe in 1990 to 1.68 Mtoe in 2010) leads to the reduction of the total energy consumption of the sector. Electricity consumption continues to increase from 1.04 Mtoe in 1990 to 1.21 Mtoe in 2010. Since 1998 with the introduction of Natural Gas in the energy mix the final consumption has three times increased and this rapidly growing trend in the near future is expected to be sustained. The final energy consumption of renewable energy sources has also increased by 60% over the last 20 years.

The share of oil products remains constant for the years 1990 and 2010 (43.7%) and oil remains the dominant energy source of final consumers in Greece. Renewables still remain a relatively small share of final energy consumption.

Table 6: Share of Final Energy Consumption by Fuel in Industry in Greece (1990 vs.2010)

Share of Final Energy Consumption by Fuel in Industry in Greece (1990 vs.2010)		
Fuels in industry	1990	2010
Oil products	43.7%	43.8%
Electricity	26%	31.6%
Wood & Waste	4.3%	7.2%
Hard & Brown Coal	25.8%	7.8%
Natural Gas	0.2%	9.7%

Source: 'Energy Efficiency Policies and Measures in Greece' , report prepared within the frames of the project Odysee – Mure (co-funded by the Intelligent Energy Europe Programme) by CRES (Minas Iatridis & Fotini Karamani), December 2012

The Non Mineral Metallic industry consumes the biggest part of final energy consumption in Greece with 1.02 Mtoe in 2010. However, the energy share of Non Mineral Metallic Industry has been slightly increased by 2.5%. The most rapidly growing branch in terms of energy consumption has been the food industry: Energy consumption of the food industry has almost doubled since 1990. As a result, the energy share of the food industry was 17% in 2010 against 8% in 1990. The energy consumption of paper industry remains almost constant and near 1990 levels. On the other hand, the energy consumption of Chemical industry decreased by 37%.

The increase of final consumption that is noticed in 2007 (figure 2) is due to the increase of cement production because of the increase in construction activity.

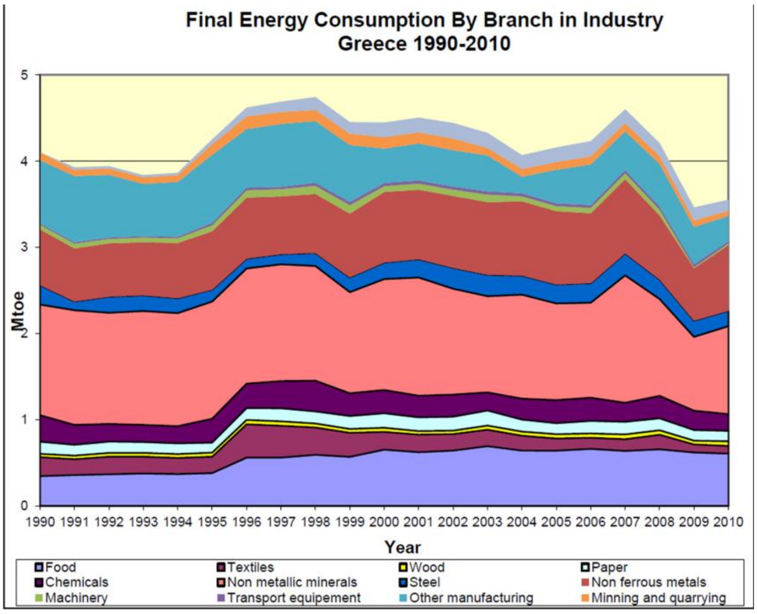


Figure 2: Final Energy Consumption by Branch in Industry in Greece (1990-2010)

Source: ‘Energy Efficiency Policies and Measures in Greece’ , report prepared within the frames of the project Odysee – Mure (co-funded by the Intelligent Energy Europe Programme) by CRES (Minas Iatridis & Fotini Karamani), December 2012

Table 7: Share of Final Energy Consumption by Branch in Industry in Greece (1990 vs.2010)

Share of Final Energy Consumption by Branch in Industry in Greece (1990 vs.2010)		
Branch in industry	1990	2010
Non metallic minerals	31.3%	28.4%
Chemicals	8.1%	4.9%
Wood	1.0%	2.0%
Paper	3.0%	2.9%
Textiles	5.1%	2.9%
Food	8.1%	16.7%
Mining and quarrying	2.0%	2.0%
Machinery	1.0%	1.0%
Non ferrous metals	16.2%	21.6%
Steel	6.1%	4.9%

Transport equipment		1.0%
Other manufacturing	18.2%	7.8%

Source: 'Energy Efficiency Policies and Measures in Greece' , report prepared within the frames of the project Odysee – Mure (co-funded by the Intelligent Energy Europe Programme) by CRES (Minas Iatridis & Fotini Karamani), December 2012

Steam boilers and Installations in Greece

There is no available information concerning the number, type, installation and capacity of steam boilers. Additionally there is no available information on the steam production in Greece.

Legislation and regulation (steam and energy efficiency)

European legislation

- Law 3661/2008 (Government Gazette 89/A/2010) "Measures to reduce energy consumption in buildings and other provisions" is the main law for the transposition of the EPBD into national legislation.

The main law has been modified through:

- Art. 10 of L.3851/2010 which included some amendments regarding the use of renewable energy sources in buildings

National legislation and/or regulation concerning steam systems, emissions

- (Government Gazette 264/B/15-4-93) - Operation term and allowable gas emissions for industrial boilers, steam generators, oil heater and air heater that operate with mazout, diesel or gas
- Government Gazette 2654/09.11.2011 Regulations concerning the operation of fixed burners for the heating of buildings and water heating
  (source http://www.elinyae.gr/el/keywords.jsp?keyword=366)

National legislation and/or regulation concerning the efficient use of energy

- Government Gazette 95/23.06.2010 Law 3855 'Measures to improve energy efficiency in end use, energy services and other provisions'
- Law 3851/2010 "Accelerating the development of Renewable Energy Sources to deal with climate change and other regulations addressing issues under the authority of the Ministry of Environment, Energy and Climate Change"

National standards for (efficient) steam boiler operation and design

- National legislation ΦΕΚ 2656/Β/28.09.2012 'Installation, Operation and Control of steam boilers'
- Government Gazette 200/17.10.2012 'Specifications for professional activities a) implementation, maintenance, repair and supervision of the operation of HVAC installations in industries b) handling and supervision of steam boilers c) implementation of technical task and supply of technical service for arc welding and oxygen welding

Support programmes from national or local government concerning the rational use of energy and/or steam

All measures that are presented are described in the database of the EU project ODYSSEE - MURE **(Mesures d'Utilisation Rationnelle de l'Energie)** supported by the Intelligent Energy Europe programme . Also these measures are mentioned in details in the 2nd National Energy Efficiency Action Plan (NEEAP) that was established and submitted in the European Commission. The 2nd EEAP presents the aggregate data of the national strategy for energy savings in all sectors of the final energy consumption.

- **Incentives for obligatory implementation of Energy Management Systems**: This measure aims to the implementation of Energy Management Systems (EMS) in all industries that are not included in Energy Services Directive (ESD). In Greece there are a lot of industries that already have implemented Environment Management Systems such as: ISO 14000, EMAS, internal EMS and HACCP. In many industries the energy management is part of these systems. The measure implementation could focus in the direct extension of these systems in order to include the energy management, too.
- **Promotion of voluntary agreements in industrial sector (status :proposed)**: This measure aims to set up a Voluntary Agreement Program, based on existing European Projects. The measure will be implemented in all industries that are not included in Emission Trading Scheme (ETS). Core of the agreements is the Action Plan, which will include the goals, the approach of partners selection, the benefits and the incentives (except of subsidies) in which an industry is committed to implement the particular measure in order to reduce the energy consumption. The commitment may cover some or all of the production systems.
- **Energy upgrading of existing buildings through third-party financing arrangements (TPF), energy performance contracting and public and private joint ventures (PPJV)-Industry Sector(status proposed):** The measure aims to the creation of an institutional framework for third-party financing (TPF) and for operational matters pertaining to energy service companies (ESCO), and regulation of existing public / private joint ventures (PPJV).

Financial instruments and or programmes rom national and/or local governments to support he rational use of energy and/or steam (subsidies, fiscal and financial instruments, bank guarantees, revolving funds, green loans,…)

National Strategic Reference Framework (NSRF)

The NSRF (National Strategic Reference Framework) 2007–2013 constitutes the reference document for the programming of European Union Funds at national level for the 2007–2013 period.The following programmes constitute the Sectoral Operational Programmes for programming period

2007-2013, as these have been officially approved by the European Commission during October–November 2007.

- OP Environment - Sustainable Development
- OP Accesibility Improvement
- OP Competitiveness and Enterpreneurship
- OP Digital Convergence
- OP Human Resources Development
- OP Education and Lifelong Learning
- OP Public Administration Reform
- OP Techincal Support for Implementation
- OP National Contingency Reserve

Source: http://www.espa.gr/en/Pages/staticSectoralOP.aspx

Check and audits

Energy Auditing Practises

The implementation of the EPBD in Greece is the responsibility of the Ministry of Reconstruction, Production, Environment and Energy. The law for the transposition of the EPBD was approved by the parliament in May 2008 (Law 3661 of the 19th of May 2008). A number of executing orders that were necessary for the implementation of the EPBD appeared as a Ministerial decision for the "Regulation of Energy Performance of Buildings" (KENAK) in April 2010 (Ministerial decision D6/B/5825 National Gazette 407/9th of April 2010). The Presidential decree necessary for the definition of the qualifications and training of energy auditors was published in the National Gazette in October 2010 (Presidential Decree 100/NG177/6th of October 2010). This was the last necessary legal document that had to be published in order to enable actual implementation of the EPBD in Greece.

Inspection of boilers and air-conditioning

The new Energy Building Code, the Technical notes issued by the Hellenic Technical Chamber and the Presidential decree 100/NG177/6th of October 2010 'Energy auditors for buildings, boilers and heating installations and cooling installations) describe in detail the procedures for auditing boilers, heating systems and air- conditioning units.

The details of the energy audit procedures are given below:

Boilers

According to the Technical note TOTEE 20701-4, National Gazette B΄2945, energy auditors should carry out audits of boilers using conventional fossil fuels as follows:

- at least every five years for boilers with an effective nominal rated power between 20 kW and 100 kW;
- at least every two years for boilers rated more than 100 kW for every fuel source, except natural gas (at least every four years).

Inspectors prepare a report assessing the thermal efficiency of the boiler and produce guidelines and recommendations to regulate, maintain, repair or replace, as necessary.
Boilers older than fifteen years and with a nominal power greater than 20 kW should be inspected once by an energy auditor together with the whole heating system, at a time and in accordance with the procedure defined in the regulation.
Inspectors draw a report assessing the efficiency of the boiler and its capacity in relation to the energy needs of the building, and give instructions and recommendations regarding the maintenance, replacement of the boiler system, and other alternatives.

According to the NG2654/09.11.2011 the maintenance of central heating installations (office buildings, stores, hotels, hospitals, industries, etc.) and steam production installations is performed once per semester. For installations with nominal rated power greater than 400 kW, the check and maintenance and emission measurements should be performed once per month.

Training of Energy auditors

The Training of Experts for Energy audits is outlined in the Presidential decree. The whole procedure foresees 120 hour training courses and exams and is organised by the Hellenic Technical Chamber, while training courses can also be carried out by other academic institutions, following the training programme elaborated and already defined by the Technical Chamber.
After the exams, if successful, the experts will be registered in a National Registry for Energy Experts.

Experts should be qualified engineers with at least 4 years of experience. Experts are distinguished in three categories of their own choice, i.e., for building inspections (60 hours of training), heating systems and boilers (30 hours of training) and A/C inspections (30 hours of training). Depending on their academic background, they are also classified into two classes. Class A experts are allowed to perform inspections and issue EPCs for buildings with heating and/or A/C installations up to 100 kW, while class B experts can perform inspections for all sizes of buildings and systems.
Experts' license has a 10 year duration and then it can be renewed.

A body of registered Experts is established in the form of an electronic database. Each expert has a registration number that is quoted in each license. The electronic database is updated by the energy auditors with the following documents:

- The Energy Performance Certification (EPC) and
- the reports of the heating and boiler installations.
- the reports of A/C installations

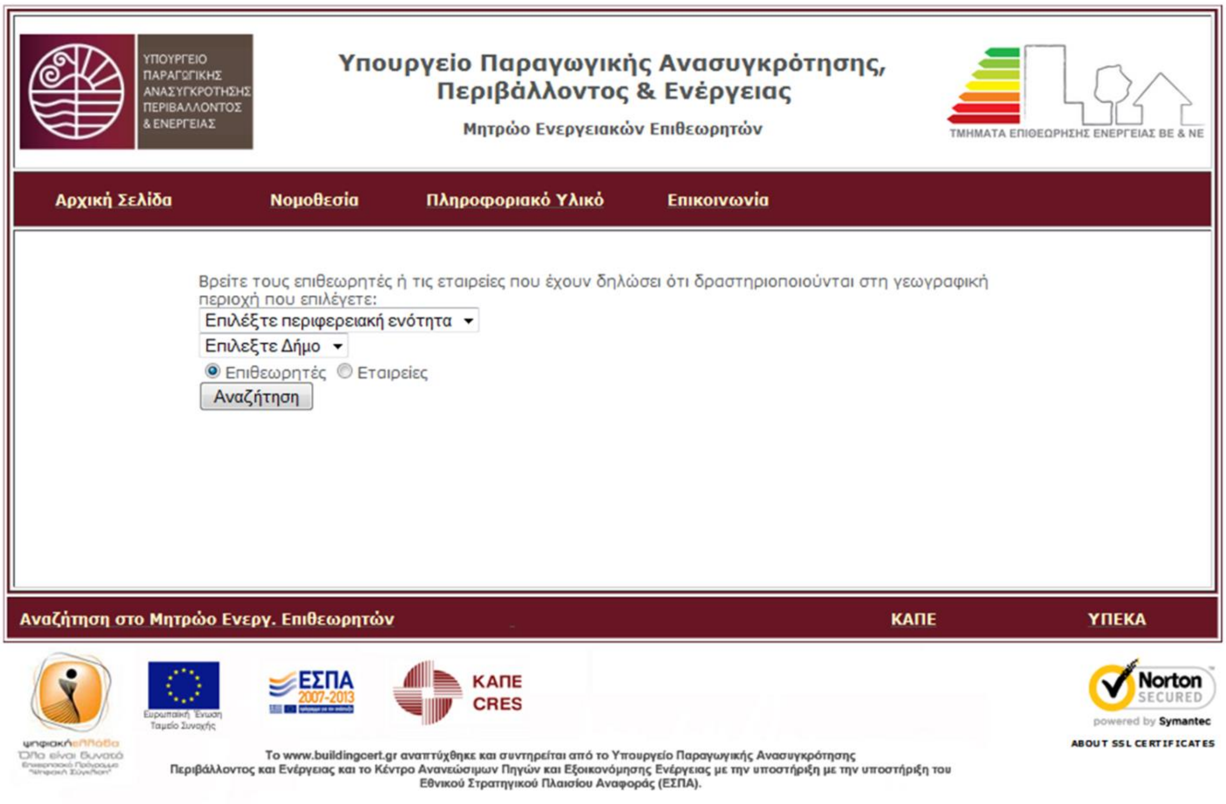


Figure2 First page of the National Registry for Energy Auditors and Energy Audits

Source : https://www.buildingcert.gr/inspectors/startValues.view

B.6 ITALY

1. Italian industry structure and the final energy consumption by industrial sector

Italian manufacturing enterprises

According to official statistic data[13], in 2012, in Italy manufacturing companies groups were more than 90,000, including 417,306 enterprises and occupy more than 5.6 million people (about one-third of employees in active enterprises in 2012). The business groups are polarized between a few structures of large size and many groups of small and very small size: the groups with at least 500 employees represent only 1.5 per cent but weigh in terms of employees by 57.6%. 10.4 percent of groups with at least one active enterprise in Italy is controlled by a non-resident. These groups, which include subsidiaries of foreign multinationals therefore, occupy 22.9 percent of all employees of the production system. The business combination through groups is a growing phenomenon (in 2008 there were about 76,000 groups with 176,000 companies), the relevance of which is expressed even more effectively on its size and economic impact on key performance indicators.

54 percent of the value added, 62 percent of sales and 80 percent of total exports (values going up respectively to 65 , 71 and 83 percent for the manufacture alone), can be attributed to the enterprises belonging to groups operating in the industry and in the private non-financial services sectors.

In particular, according to the data[14] elaborated from the same source[[1]], in 2012 Chemical companies in Italy amounted for 4,436; Pharmaceutical for 463; Rubber & Plastic for 10,588; Pulp & Paper for 4,054; Printing for 16,289; Textile & Clothing for 47,667 and Beverage & Food for 57,991.

Final energy consumption by manufacturing sector in Italy

The final energy consumption by manufacturing industry is obtained from the Italian national energy balance[3] (2013) and reported in Table 1.

Table 1 Final energy consumption by manufacturing sector (2013)

Industry Sector		Iron & Steel	Extractive	Non-ferrous metal	Mechanical	Food& Beverage	Textile & Clothing	Building materials	Glass & Ceramics	Chemical	Petrol-chemical	Pulp & Paper	Other manufact.
Final energy consumption	kJ x 10^9	58.953	1.278	6.624	39.131	26.916	11.731	32.170	23.101	37.674	7.861	25.629	9.278
	Mtoe	5,8953	0,1278	0,6624	3,9131	2,6916	1,1731	3,217	2,3101	3,7674	0,7861	2,5629	0,9278

The trend in final energy consumption of the industry sector in Italy for the period 1992-2013 shows a growth until 2003, when it reached 40.7 Mtoe (+ 17.9% compared to 1992), then a phase of decline

[13] ISTAT Annual Report 2015

[14] Trend Statmanager, https://infogr.am/statmanager

(-33.7% in 2003-2013), more accentuated in recent years mainly due to the economic and financial crisis. As shown in Figure 1, the reduction of consumption affected all sectors, in particular Textiles (-52.7%), Non-metallic minerals (-41%), Mechanical (-30.1%) and Food (-29.7%).

Figure 1: Energy consumption by industrial branch (Mtoe), 1992-2013[15]

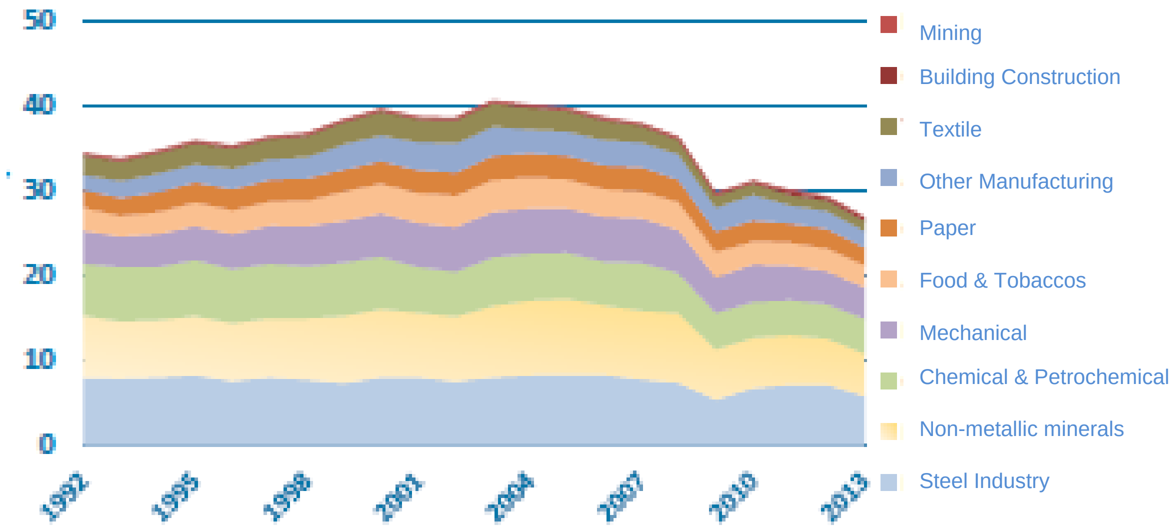
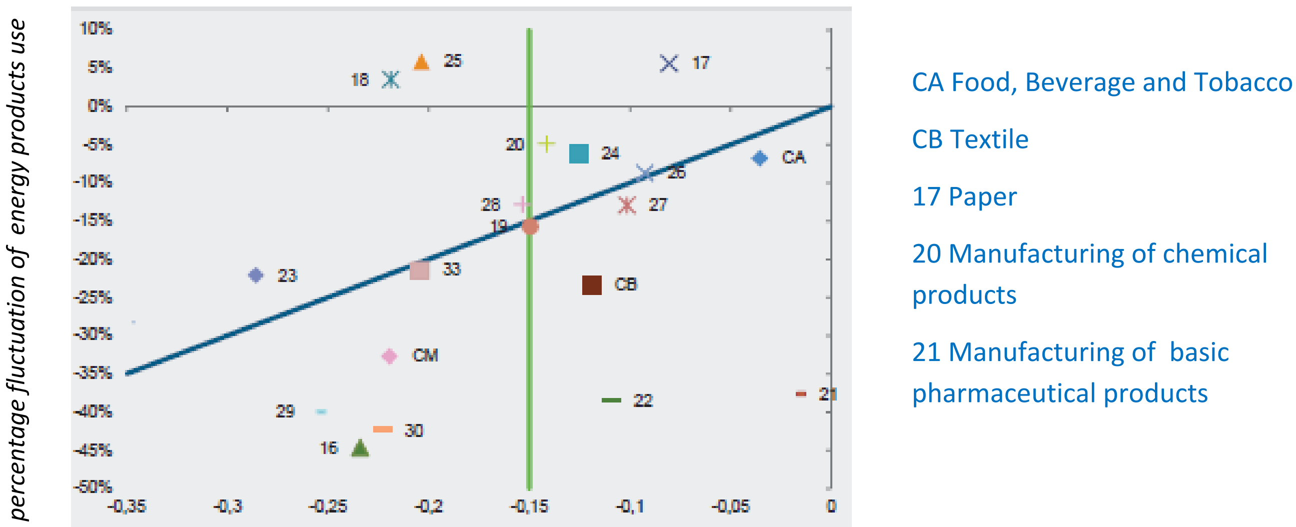


Figure 2 shows that the performance of the different manufacturing activities is quite scattered[1]. Only branches below the blue line – along which energy intensity has been steady- have achieved an improvement of the energy efficiency.

Figure 2: Energy uses vs Industrial production – Years 2008-2012 (% fluctuation) [1]



[15] The Italian National Energy Balance, source: Italian Ministry of Economic Development

Focussing on the performances of the branches of interest of STEAM-UP Project, we can see that, during the period 2008-2012, the Food, Beverage and Tobacco as well as Textile branches have reduced their energy intensity (i.e. they have achieved an improvement of their own energy efficiency), while the Paper and the Chemical branches have increased their energy intensity.

2. Steam Generation in the Pulp and Paper, Chemical Manufacturing, Petroleum Refining and Food and Beverage Industries

Energy consumption for steam production accounts for a significant amount of the total industrial process energy use, particularly among the sectors like Pulp & Paper, Textile & Clothing, Chemical and Petrochemical. Because those industry groups represent both an important national interest and a large portion of the nation's overall energy use, it is important not only to understand how these industries use energy, but especially how they generate and use steam. This Section of the report assesses steam generation, specifically the amount of fuel used to generate steam and the amount of steam generated by the target branch: pulp and paper, chemical manufacturing, petroleum refining and Food &Beverage. Combining data from the literature[16], with energy use estimates for key processes and products, we have implemented a top-down analysis of the steam generation in the five target industries.

There are five industry groups that are the focus of STEAM-UP efforts; they include the Pulp & Paper, Textile & Clothing, Chemical, Petrochemical industries along with Food & Beverage because these five groups of industries are the major steam users.

Key Results

Table 2 reports final energy consumption in these five industrial sectors[[2]].

Table 2 Final energy consumption in selected industrial sectors (Italy)

Natural gas					Electricity			Other fuels derived from petrochemical			Total	
	10^9 kcal	Mtoe	% total		10^9 kcal	Mtoe		10^9 kcal	Mtoe		10^9 kcal	Mtoe
Food & Beverage	14105	1,4105	0,52		10279	1,0279		2532	0,2532		26916	2,6916
Textile & clothing	5857	0,5857	0,50		5060	0,506		814	0,0814		11731	1,1731
Chemical	20207	2,0207	0,54		16474	1,6474		993	0,0993		37674	3,7674
Pulp and paper	17095	1,7095	0,67		7808	0,7808		726	0,0726		25629	2,5629
Petrochemical	4497	0,4497	0,59		1341	0,1341		1823	0,1823		7661	0,7661
Total	61761	6,1761	0,56		40962	4,0962		6888	0,6888		109611	10,9611

The above data has been shown, moreover, that the consumption of natural gas is prevalent compared to other fuels (representing approximately only 10% of the total consumption of natural gas).

[16] ENEA's operating guidelines for White Certificate

The number of companies active in those five industrial sectors[17] is given in Table 3, in which the final natural gas consumption [[2]] together with gas consumption for steam production in the corresponding sectors are also reported.

Table 3 Number of companies in five selected industrial sectors and their gas consumption for steam production

Sector		Food& Beverage	Textile & clothing	Chemical	Pulp & paper	Petrochemical
National final gas consumption	MWh	16.401.163	6.810.465	23.496.512	19.877.907	5.229.070
% of final gas consumption used for steam production	%	60	80	90	95	100
Gas consumption used for steam production	MWh	9.840.698	5.448.372	21.146.860	18.884.012	5.229.070
Number of companies	**n**	**60.944**	**16.556**	**18.614**	**4.472**	

To obtain the gas consumption for steam production, it has been assumed that different percentages of thermal energy are consumed by industry sectors; based on those assumed percentages the gas consumptions for steam production have been calculated for the five STEAM-UP interested industrial sectors.

Further, based on the number of companies and their annual gas consumptions for steam production, the total number of installed steam generators as well as total installed capacities in those five sectors have been estimated (Table 4).

Moreover, the annual replacement of steam generators in the five selected sectors has been estimated, by considering the average operating life of the generators varies according to the capacity (15 years for small one and 30 for big one). The results are given in Table 5.

Table 4 Total number of installed steam generators and the total installed capacities in those five sectors

	Installed capacity	Average installed capacity		Food& Beverage		Textile & clothing		Chemical	Pulp & paper		Petrochemical	n. steam generators	MW	MW_{spec}
t/h	1,0-2,0	1,5	n	50%	2.726	30%	302	899				**3.927**	4.027	1,03
t/h	2,0-4,0	3	n	20%	545	40%	201	450				**1.196**	2.453	2,05
t/h	4,0-10,0	7	n	20%	234	30%	65	193				**491**	2.350	4,79
t/h	10,0-20,0	15	n	10%	55			90	40%	109		**254**	2.216	8,74
t/h	20,0-40,0	30	n					45	60%	82	38	**165**	2.877	17,48
Total number of steam generators in operation (A)				3.560		568		1.676	191		38	**6.032**	24.666	4,09

[17] the Register of the Chamber of Commerce of 05.31.2015 (NACE code)

Total number of steam generators installed (A x 2, taking account of the reserve)	7.119	1.136	3.352	382	76	**12.064**	

Note:

It is assumed that the steam is produced by steam generators with 5 different installed capacities as indicated the table. In particular, for the different sectors we have been adopted the following assumptions to calculate the number of generators installed:

- the total number of generators in operation has been doubled, by taking account of the backup.
- the specific power is the ratio of the total power installed for each capacity and the number of generators by capacity

Table 5 Estimated annual replacement of steam generators in the five selected sectors

	Installed capacity	Average ins. capacity		Average operating life (year)	Annual replacement rate	Number of steam generators replaced/year
t/h	1,0-2,0	1,5	n	15	6,7	**262**
t/h	2,0-4,0	3	n	15	6,7	**80**
t/h	4,0-10,0	7	n	20	5,0	**25**
t/h	10,0-20,0	15	n	20	5,0	**13**
t/h	20,0-40,0	30	n	30	3,3	**5**
Annual replacement rate		Total				**384**

3. Legislation and regulation (steam and energy efficiency)

In Italy, national legislations and/or regulations applicable in steam system are:

Ministerial Decree Nr. 329/04: dealing with Safety and Hygiene - prevention of occupational accidents - systems and pressure vessels. In particular Article 1, paragraph 2 provides for the following:

- Verification of "first plant" or of "commissioning" referring to pressure equipment or to sets when inserted and assembled by the user. This verification, carried out at the request of the user, regards the establishment of the correct installation of the equipment or sets pressure on the system. The verification of commissioning consists of a verification document and correct installation on the field, and in a test run (or "exercise")
- Checks periodic retraining, to be made after commissioning at regular intervals. Users of equipment and sets put into service are obliged to subject them to periodic checks, or periodic regeneration. The frequency of checks is determined by reference to some technical parameters of construction. For Heat generators with capacity higher than 116 kW, the frequency inspections is 5 years. A generator of steam or superheated water must undergo two

different tests of integrity (an inside visit and a complete check every 10 years) and of regular operation (accessories operation)

DPR 151/2011 concerning the activities under the control of Firemen Dpt. for fire prevention inspections; in particular, the list of equipment such as steam generators fall within the broader category of "heat production plants powered by solid fuel, liquid or gas," which is listed as category of Annex 74 of the DPR 151/2011.

The main national legislation ruling the implementation of Energy Diagnosis is represented by **Lgs. Decree 102/2014 of July 4, 2014**, implementing Directive 2012/27/ EU. Article 8 of this Legislative Decree introduces the obligation of implementing Energy Diagnosis in enterprises operating in energy-intensive sectors and in large companies.

The diagnosis has to be done according to the criteria contained in Annex 2 of the abovementioned Decree and the results shall be communicated to ISPRA and ENEA, by 5 December 2015 for the first time, and then every four years.

The enterprises subject to the obligation are:

- Energy-intensive enterprises (energy-intensive according with ex Lgs.D. 83/2012, MD 05.04.2013) regardless of their size. These are companies with high energy consumption, ex Lgs.D. 83/2012, the companies for which, in the reference year, occurred both of the following conditions:
  a) they have used, for the implementation of their business, at least 2.4 GWh of electricity, or at least 2.4 GWh of energy in a different form of electricity;
  b) the ratio between the actual cost of the total quantity of energy used for the conduct of its activities, ... omissis..., and the turnover, ... omissis..., is not lower than the 3%.
- or Large Enterprises (companies employing more than 250 people, with an annual turnover exceeding 50 million Euros or whose annual budget exceeds 43 million Euro).

Companies certified ISO 50001, EN ISO 14001, ISO 9001 or EMAS do not have the obligation of implementing energy audits, if their system includes an energy audit carried out in accordance with the dictates of the Annex 2 to the Legislative Decree no. 102/14.

The main support programmes from national or local government to stimulate the rational use of energy and/or steam are the White Certificates Scheme.

The white certificates scheme, also known as “Energy Efficiency Certificates” (EEC), are tradable instruments giving proof of the achievement of end-use energy savings through energy efficiency improvement initiatives and projects.

The white certificates scheme was introduced into the Italian legislation by the Ministerial Decrees of 20 July 2004, as subsequently amended and supplemented. Under the scheme, electricity and natural-gas distributors are required to achieve yearly quantitative primary-energy saving targets, expressed in Tonnes of Oil Equivalent (TOE) saved. Each certificate is worth one tonne of oil equivalent (toe) saved.

Electricity and gas distributors may fulfil their obligation by implementing energy efficiency projects entitling to white certificates or by buying white certificates from other parties in the Energy Efficiency Certificates Market that is organised by GME.

High-Efficiency Cogeneration (HEC) units may access the white certificates scheme under the terms, conditions and procedures established by the Ministerial Decree of 5 September 2011.

The applicable legislative/regulatory framework was recently changed by the Decree of 28 Dec. 2012. The decree sets national quantitative energy-saving targets - incremental over time - for electricity and gas distributors for the years from 2013 to 2016. The decree also introduces new parties eligible to submit projects with a view to obtaining white certificates.

Parties eligible to submit projects for accruing white certificates are: i) electricity and gas distributors with more than 50,000 final customers ("obliged parties") and their controlled companies; ii) non-obliged distributors; iii) companies operating in the sector of energy services (ESCOs); and iv) companies or organisations having an energy manager or an ISO 50001-certified energy management system in place.

4. Check and audits

From the interviews with steam responsible person of enterprises, it has been noted that steam generators and steam distribution system are regularly checked. The check frequency is generally annual, and the checks are carried out mainly on the parameters that affect the proper and efficient operation of the system.

Analysis on the percentage of oxygen, carbon dioxide, nitrogen oxide and temperature of the exhaust gases are regulars in the boiler house. In the distribution system, typically, audit focuses on finding and eliminating steam leaks, pipe and steam traps failures, is essential to get significant energy savings. Often, however, a poor access to the components limits the regular inspection.

In Italy, for facilitate the implementation of European EED (Energy Efficiency Directive 2012/27/EU), Italian Government has put in force the Decree **102/2014 of July 4, 2014,** which ruling the implementation of Energy Diagnosis, including in its Annex 2 also the general approach of industrial energy auditing. However, other energy audit methodologies and tools have been identified, the essential information of those methodologies/tools are reported in Annex I.

5. Steam Experts and Expertise

In Italy there are the standards for qualifying experts for conducting steam generators; for instance, OJ 16 April 1974 n. 99, based on which the qualification of steam experts includes 4 levels:

- Level 1 – steam expert enables to conduct any type of steam generators, for any heat exchange surface;
- Level 2 - steam expert enables to conduct any type of steam generators having a steam production capacity up to 20 t/h;
- Level 3 - steam expert enables to conduct any type of steam generators having a steam production capacity up to 3 t/h
- Level 4 - steam expert enables to conduct any type of steam generators having a steam production capacity up to 1 t/h

There are different training courses organized for qualifying steam experts, the identified training materials are given in Annex II.

6. Key players in Industrial Steam (Force Field Analysis)

Who are the key players in the field of steam use, technology (transfer) and expertise?

a. Industrial enterprises
b. Equipment suppliers
c. Technology suppliers

Currently, there are not steam experts officially certified; however, the certified experts in energy management (EM) operating in industrial sectors are able to carried out energy audit of steam systems. The following table gives a part of EM experts in industrial sector certified by ACCREDIA (the Italian National Accreditation Body appointed by the State to perform accreditation activity).

Name	Operating sector	Location	Duration of accreditation
ALBERTI MASSIMO	Civil & Industrial	FAENZA - EMILIA ROMAGNA	2/7/2012 - 1/7/2017
ANDREOLI PIERGABRIELE	Civil & Industrial	MODENA (MO) - EMILIA ROMAGNA	31/1/2014 - 30/1/2017
ANFOSSO THOMAS	Civil & Industrial	SESTO SAN GIOVANNI (MI) - LOMBARDIA	31/1/2014 - 30/1/2017
ANNINO GIULIANO	Civil & Industrial	MILANO (MI) - LOMBARDIA	8/7/2013 - 7/7/2016
ANTINUCCI MARCELLO	Civil & Industrial	BOLOGNA (BO) - EMILIA ROMAGNA	2/7/2012 - 1/7/2017
APREA ANTONIO	Civil & Industrial	MILANO (MI) - LOMBARDIA	24/9/2013 - 23/9/2016
ARRIGA TIZIANO	Industrial	TRAVAGLIATO (BS) - LOMBARDIA	29/4/2013 - 29/4/2016
ATZEI MATTEO	Industrial	MILANO (MI) - LOMBARDIA	22/3/2013 - 22/3/2016
BALDUCCI MICHELE	Industrial	FAENZA (RA) - EMILIA ROMAGNA	2/7/2012 - 1/7/2017
BARBARESI DAVIDE	Industrial	MONTEMAGGIORE AL METAURO (PS)	12/7/2012 - 12/7/2015
BARETICH FRANCO	Industrial	MILANO (MI) - LOMBARDIA	21/6/2013 - 20/6/2016
BASOSI RICCARDO	Civil & Industrial	FIRENZE (FI) - TOSCANA	2/7/2012 - 1/7/2017
BELLICINI VITTORIO	Civil & Industrial	BIENNO (BS) - LOMBARDIA	1/7/2013 - 30/6/2018
BELLO LEONARDO	Industrial	TORINO (TO) - PIEMONTE	28/6/2013 - 28/6/2016
BELVIGLIERI FILIPPO	Civil & Industrial	VERONA (VR) - VENETO	1/7/2013 - 30/6/2018
BOLLATI EDOARDO AMBROGIO	Industrial	BERGAMO (BG) - LOMBARDIA	9/12/2013 - 9/12/2016
BONAZZI ROBERTO	Civil & Industrial	COMACCHIO (FE) - EMILIA ROMAGNA	19/12/2013 - 18/12/2016
BOTTEGA MASSIMO	Civil & Industrial	LUCCA (LU) - TOSCANA	17/4/2013 - 16/4/2016
BROCCARDO	Industrial	GENOVA (GE) - LIGURIA	2/7/2012 - 1/7/2017

Name	Operating sector	Location	Duration of accreditation
MARCO			
BRUNO CLAUDIO	Industrial	ROCCASPINALVETI (CH) - ABRUZZO	2/7/2012 - 1/7/2017
BUGLISI FRANCESCO	Civil & Industrial	TERME VIGLIATORE (ME) - SICILIA	2/1/2013 - 1/1/2016
CAPOBIANCO ANTONIO	Industrial	FOGGIA (FG) - PUGLIA	22/3/2013 - 22/3/2016
CARDILLI SAVINO	Civil & Industrial	LISCATE (MI) - LOMBARDIA	17/7/2013 - 16/7/2016
CARLESI ALBERTO	Civil & Industrial	VERONA (VR) - VENETO	31/7/2013 - 30/7/2016
CARLI MAURIZIO	Industrial	TENNA (TN) - TRENTINO ALTO ADIGE	15/2/2013 - 15/2/2016
CARRAFFA BRUNO	Industrial	TRECASTAGNI (CT) - SICILIA	14/11/2013 - 14/11/2016
CASTELLI ERIKA	Industrial	VEDANO AL LAMBRO (MB) - LOMBARDIA	8/7/2013 - 7/7/2016
CAVALLOTTI IRMA	Industrial	BERGAMO (BG) - LOMBARDIA	22/3/2013 - 22/3/2016
CECCARINI FILIPPO	Industrial	SAN GIUSTINO (PG) - UMBRIA	1/7/2013 - 30/6/2018
D'AGOSTINO VINCENZO	Industrial	ZUMPANO (CS) - CALABRIA	29/4/2013 - 29/4/2016
D'ALESSANDRO LEONE	Industrial	MILANO (MI) - LOMBARDIA	1/7/2013 - 30/6/2018
D'AURELIO ENRICO	Industrial	PESCARA (PE) - ABRUZZO	1/7/2011 - 30/6/2016
DE FRANCQUEVILLE D'ABANCOURT IGNACE MARIE BERNARD	Industrial	MONZA (MB) - LOMBARDIA	2/7/2012 - 1/7/2017
DEL VECCHIO LUCA	Industrial	ROMA (RM) - LAZIO	24/5/2013 - 24/5/2016
DI FOLCO ANTONIO	Industrial	ARPINO (FR) - LAZIO	22/3/2013 - 22/3/2016
DI FRANCO PASQUALE	Industrial	MONTEROTONDO (RM) - LAZIO	2/7/2012 - 1/7/2017
DILUCIA LA PERNA DARIO	Industrial	MILANO (MI) - LOMBARDIA	1/7/2011 - 30/6/2016
ELIA CARLA	Industrial	CAVALLINO (LE) - PUGLIA	20/8/2012 - 19/8/2015
FARNÈ STEFANO	Industrial	MILANO (MI) - LOMBARDIA	21/6/2013 - 20/6/2016
FELICI CINZIA	Industrial	ASCOLI PICENO (AP) - MARCHE	1/7/2013 - 30/6/2018
FRUET NICOLA	Industrial	PERGINE VALSUGANA (TN) - TRENTINO ALTO ADIGE	15/2/2013 - 15/2/2016

Name	Operating sector	Location	Duration of accreditation
GALVANI TOMMASO	Industrial	TRAVERSETOLO (PR) - EMILIA ROMAGNA	19/12/2013 - 18/12/2016
GOFFO ELIGIO	Industrial	RUBANO (PD) - VENETO	9/5/2013 - 9/5/2016
GREPPI CAPPA ALESSANDRO	Civil & Industrial	MILANO (MI) - LOMBARDIA	21/6/2013 - 20/6/2016
IACOMELLI ALDO	Civil & Industrial	MONTECATINI VAL DI CECINA (PI) - TOSCANA	1/7/2013 - 30/6/2018
LA MURA SERGIO	Industrial	MILANO (MI) - LOMBARDIA	17/8/2013 - 16/8/2016
LANDI LORENZO	Industrial	NOVARA (NO) - PIEMONTE	6/11/2012 - 5/11/2015
LANZAFAME ROSARIO	Industrial	ZAFFERANA ETNEA (CT) - SICILIA	17/10/2013 - 17/10/2016
MAGNANI CHIARA	Industrial	MISANO ADRIATICO (RN) - EMILIA ROMAGNA	1/7/2013 - 30/6/2018
MARIOTTI MICHELE	Industrial	VICCHIO (FI) - TOSCANA	1/7/2013 - 30/6/2018
MIGLIORA RENATO	Industrial	TORTONA (AL) - PIEMONTE	2/7/2012 - 1/7/2017
PALMIERI CLAUDIO	Industrial	MODENA (MO) - EMILIA ROMAGNA	1/4/2015 - 31/3/2020
PAOLINI MAURIZIO	Civil & Industrial	AVEZZANO (AQ) - ABRUZZO	1/7/2013 - 30/6/2018
PARLANTI ALBERTO	Industrial	LIVORNO (LI) - TOSCANA	22/3/2013 - 22/3/2016
PARMA FRANCO	Industrial	PIAN DI SCO' (AR) - TOSCANA	4/1/2013 - 3/1/2016
PEANO FABIO	Industrial	ALBA (CN) - PIEMONTE	15/2/2013 - 15/2/2016
PERINI EMILIO	Industrial	CIVITANOVA MARCHE (MC) - MARCHE	15/2/2013 - 15/2/2016
PERRONE ROBERTO	Industrial	PINEROLO (TO) - PIEMONTE	29/4/2013 - 29/4/2016
PETRECCA GIOVANNI	Civil & Industrial	CAVA MANARA (PV) - LOMBARDIA	2/7/2012 - 1/7/2017
PICCHIOLUTTO SANDRO	Civil & Industrial	MODENA (MO) - EMILIA ROMAGNA	2/7/2012 - 1/7/2017
PONTA ANDREA	Industrial	TORINO (TO) - PIEMONTE	21/2/2013 - 21/2/2016
PONTARA MAURIZIO AMOS	Industrial	POGLIANO MILANESE (MI) - LOMBARDIA	2/10/2013 - 1/10/2016
PROSPERI MARCO	Civil & Industrial	SALSOMAGGIORE TERME (PR) - EMILIA ROMAGNA	24/9/2013 - 23/9/2016
RAMINA MASSIMO	Industrial	PIAZZOLA SUL BRENTA (PD) - VENETO	24/7/2013 - 24/7/2016

Name	Operating sector	Location	Duration of accreditation
RIGOLI CLAUDIO	Industrial	ROMA (RM) - LAZIO	18/3/2013 - 17/3/2016
RIVA MATEUSZ	Industrial	SPIRANO (BG) - LOMBARDIA	31/10/2013 - 30/10/2016
RIVA MAURIZIO	Industrial	MILANO (MI) - LOMBARDIA	9/5/2013 - 9/5/2016
RIVERO FAUSTO	Civil & Industrial	TORINO (TO) - PIEMONTE	2/7/2012 - 1/7/2017
RIZZINELLI DAVIDE	Industrial	MAIRANO (BS) - LOMBARDIA	27/9/2013 - 27/9/2016
ROMANI RINO	Industrial	ROMA (RM) - LAZIO	1/1/2015 - 31/12/2019
SALVATORI CRISTIAN	Industrial	PRIGNANO SULLA SECCHIA (MO) - EMILIA ROMAGNA	1/7/2013 - 30/6/2018
SANTAGATI ALESSANDRO	Civil & Industrial	ROMA (RM) - LAZIO	18/7/2013 - 17/7/2016
SAVINO GIANCARLO	Industrial	SALERNO (SA) - CAMPANIA	2/7/2012 - 1/7/2017
SAVOLDELLI ROBERTO	Industrial	DARFO BOARIO TERME (BS) - LOMBARDIA	1/7/2011 - 30/6/2016
SCIALDONI RAFFAELE	Industrial	ROMA (RM) - LAZIO	1/7/2010 - 30/6/2015
SINELLI MAURIZIO	Civil & Industrial	MILANO (MI) - LOMBARDIA	8/7/2013 - 7/7/2016
SOTTE MARCO	Civil & Industrial	CIVITANOVA MARCHE (MC) - MARCHE	1/7/2013 - 30/6/2018
TERLIZZESE TIZIANO	Civil & Industrial	ANZOLA DELL'EMILIA (BO) - EMILIA ROMAGNA	21/6/2013 - 20/6/2016
TRIVELLA ANTONIO	Civil & Industrial	PISA (PI) - TOSCANA	2/7/2012 - 1/7/2017
VALLE FABRIZIO	Industrial	SPINETTA MARENGO (AL) - PIEMONTE	24/5/2013 - 24/5/2016
VECCHIATO LUCA	Industrial	PADOVA (PD) - VENETO	2/7/2012 - 1/7/2017
VERGERIO GIOVANNI		ZELO BUON PERSICO (LO) - LOMBARDIA	2/7/2012 - 1/7/2017
VEZZA SILVIO	Civil & Industrial	MILANO (MI) - LOMBARDIA	21/10/2013 - 20/10/2016
VIGNATI SIGFRIDO	Industrial	ROMA (RM) - LAZIO	1/1/2015 - 31/12/2019
VIRGILLITTO DAVIDE GIUSEPPE	Industrial	MILANO (MI) - LOMBARDIA	22/3/2013 - 22/3/2016
VITALI DAVIDE	Industrial	ANCONA (AN) - MARCHE	2/7/2012 - 1/7/2017

B.7 NETHERLANDS

Industrial Enterprises

In the Netherlands we have about 50.175 industrial enterprises (2009, CBS). Table 1, division per sector (in Dutch). The numbering in front of the sectors are based on a code (SBI). The following sectors are translated, because of their use of Industrial Steam:

15 – Processing of Food and Drinks – 4385 companies

17 – Processing of textiles – 1455 companies

21 – Processing of Cardboard and paper – 400 companies

24 – Processing of chemicals – 960 companies

25 – Processing of rubber and plastics – 1290 companies

Table 0.1 division per sector

Bedrijven; economische activiteit, grootte en rechtsvorm, SBI'93		
	Onderwerpen	Bedrijven
	Bedrijfskenmerken	Totaal aantal bedrijven
Bedrijfstakken	Perioden	aantal
D Industrie	2009, 1 januari	50175
15 VV voedingsmiddelen en dranken	2009, 1 januari	4385
16 Verwerking van tabak	2009, 1 januari	20
17 Vervaardiging van textiel	2009, 1 januari	1455
18 VV kleding; bereiden en verven van ..	2009, 1 januari	1350
19 VV leer en lederwaren (geen kleding)	2009, 1 januari	305
20 Houtindustrie en vervaardiging van ..	2009, 1 januari	1960
21 VV papier, karton en papier- en ..	2009, 1 januari	400
22 Uitgeverijen, drukkerijen en repro	2009, 1 januari	7105
23 Aardolie- en steenkoolverwerkende ..	2009, 1 januari	40
24 Vervaardiging van chemische producten	2009, 1 januari	960
25 VV producten van rubber en kunststof	2009, 1 januari	1290
26 VV glas, aardewerk, cement-, kalk- ..	2009, 1 januari	1725
27 Basismetaalindustrie	2009, 1 januari	330
28 VV producten van metaal (geen ..	2009, 1 januari	8590
29 VV machines en apparaten	2009, 1 januari	5040
30 VV kantoormachines en computers	2009, 1 januari	165
31 VV overige elektrische machines, ..	2009, 1 januari	1050
32 VV audio-, video- en ..	2009, 1 januari	490
33 VV medische apparaten en ..	2009, 1 januari	2295
34 VV auto's, aanhangwagens en opleggers	2009, 1 januari	735
35 VV transportmiddelen (geen auto's ..	2009, 1 januari	2065
36 VV meubels; vervaardiging van ..	2009, 1 januari	8120
37 Voorbereiding tot recycling	2009, 1 januari	280

The total (estimated) energy use in the industrial sector is about 1213,49 PJ (energy sector excluded). The total energy consumption in the Netherlands is about 3255,76 PJ (CBS, 2013)

6. Installations

In The Netherlands there are about 3000 steam boilers in operation. This is an estimated figure based on a Best Practice of 2014. The capacity differ a lot, sometimes former (bigger) central systems are replaced by smaller de-central boilers. The capacities are based on the amount of steam the processes use. Electricity is also processed by steam, but excluded in this survey. About 40% of the industrial use of gas is used in steamboilers. They are good for about 2-3 billion Euro's and produce about 82.000.000 tons of steam each year. (source: www.stoomplatform.nl)

Based on the experience of Industrial Energy Experts the most used steamboilers in the industry are fire tube boilers (used on a mid-pressure of 1,5 – 25 bar). The common used fuel type in the Netherlands for steamboilers is natural gas.

Based on experience and observations, the most boilers have a long life time (> 20 yr.) although the burners will have to get replaced once in a while. In 2017 new emission rules will be a trigger for replacing the burners.

Sales figures and developing trends

There are no figures for the amount of newly installed steam boilers in the The Netherlands in one year but the total amount of steam boilers is shrinking over the years. In 1960 about 5.000 steamboilers where in operation and in 2007 about 3.000. Out of the 3.000 steamboilers, 500 are used for the production of electricity and are therefor excluded from this survey.

The shrinking of the amount of steamboilers in Dutch industries are explained by:

- Shrinking of Dutch companies in steam using sectors
- Better use of heat, no heating with steam but hot-water-boilers

Energy use and potential

About 82.000.000 ton steam is produced each year (www.stoomplatform.nl). Without losses this can be realized by using 2,636 GJ/ton. So about 216 PJ is used for steam production in Industrial companies. With an overall efficiency of 70%, 308 PJ is needed. This is an estimation based on www.stoomplatform.nl.

About 32% of the total gas-use in The Netherlands is used in industrial companies. (www.stoomplatform.nl) and 25% in SME's. The total industrial energy-use in The Netherlands is about 1213 PJ, so 25% is used for steam production.

C. de Greef, an independent steam expert, estimated that the saving potential in steam production is about 2-3% and in steam use 7-8%. Based on these figures the estimated saving potential for The Netherlands is 30PJ or 2-3% of the total energy use in the Dutch Industrial sector.

Because of the fact that the chemical Industry is the largest energy-user, the highest impact is expected in this sector.

Table: Energy use in different sectors (no SBI-code)

SBI/ Industry (2009 CBS)	Energy (CBS/ECN 2014)
15 – Processing of Food and Drinks – 4385 companies	78 PJ (incl. tobacco)
17 – Processing of textiles – 1455 companies	NA
21 – Processing of Cardboard and paper – 400 companies	29 PJ (incl. graphical industry)
24 – Processing of chemicals – 960 companies	864 PJ (incl. pharmaceutical industry)
25 – Processing of rubber and plastics – 1290 companies	NA

The processes in the chemical, and other processing industries, that rely on steam are heating processes. The highest impact are in reduction of heat-use or re-use of heat.

Estimated saving opportunities:

Based on interviews and surveys, the most promising steam saving measures that (still) can be taken are:

a. ***Heat recovery (exhaust, blowdown, condensate return)***
Not only with the production of steam (economizers a.o.) but also in the re-use of condensate.

b. ***Operation (operation pressure, stand still, idle mode (no demand)***
Although most companies don't want to take the risks of water hammer and erosion, and therefor don't want to shut down the boiler during weekends or when there's no production, the possibility of reducing the pressure when there's no demand is promising. Insight in performance, needed operation pressure is necessary.

c. ***Distribution (steam traps, control and design of heat exchangers,…)***
Absolutely, in the production an efficiency of 90% is normal and through operation and distribution losses the total efficiency is generally 65% (Source: best practice).

d. ***Control***
Not only internal (temperature) control and obligatory equipment control and emission control but also controlling the efficiency, CO/O2-control by installing new burners.

e. Newly engineered steam systems

The need of steam is changing, companies have a reducing steam demand, may be offered a newly engineered steam system with more flexibility and better steam use.

7. Sectors and processes

The steam use over the specific processes (drying, evaporation, distillation, heating/boiling) within the companies is different per sector. In the next table the different sectors and their steam using processes are mentioned. Note: the processes that are using the most steam are mentioned first.

Sector	Steam-processes
Paper industries (business association: VNP)	Drying; wet paper is dried by using steam in cylinders Bleaching; paper pulp is bleached at certain temperatures Building heating Making glue; an open steam user within paper making
Chemical industries (business association: VNCI)	Process heating in various processes like: • Acceleration of endotherm processes • Calender machine Building heating
Food processing (business association: Vigef, COV, NEPLUVI)	Killing bacteria and virus in processes like: • Sterilization • Pasteurization • Cooking CIP- (cleaning in place) water-heating Frying (meat)
Plastics and rubber industries (business association: NRK)	Vulcanization EPS-processing Melting and drying

Most sectors have their own business association. Their main objectives are information ordering and facilitating and speaking partner with governments.

In the Netherlands Long Term Agreements on energy saving at enterprises are made between sector organisations and National Government

Legislation and regulation

European legislation and regulation

The following European laws and regulations are applicable in relation to steam systems:

- PED –directive (97/23/EC): From 30 May 2002 the pressure equipment directive is obligatory throughout the EU. The directive provides, together with the directives related to simple pressure vessels (2009/105/EC), transportable pressure equipment (99/36/EC) and Aerosol

Dispensers (75/324/EEC), for an adequate legislative framework on European level for equipment subject to a pressure hazard.

- IPPC-directive: The IPPC Directive has recently been codified (Directive 2008/1/EC). In essence, the IPPC Directive is about minimising pollution from various industrial sources throughout the European Union. Operators of industrial installations operating activities covered by Annex I of the IPPC Directive are required to obtain an environmental permit from the authorities in the EU countries. About 52.000 installations are covered by the IPPC Directive.

Dutch legislation and regulation on steam production and steam use

In the Netherlands the following national legislation and/or regulation does apply when it comes to steam production and steam use (see table)

Table Legislation and regulation

Part of regulation	name	Main obligations	Enforcement	Checking
Pressure equipment	Warenwet	Control pressure equipment by "Aangewezen Keurings Instituut" EBI-keuring (eerste in bedrijfsstelling)	Loyds (stoomwezen) as an AKI. Warenwet (PED based)	Loyd's
Burners	IPPC/ activiteitenbesluit	Control, by measuring and installing	Wet milieubeheer	SCIOS, EBI (installation companies) e-MJV (IPPC)
Emissions	Bees A, Bees B, BEMS	Control by measuring	Wet Milieubeheer	Installation companies. RUD's
People welfare	ARBO (law)	Employees need to work in a healthy and save environment which the company has to provide	ARBO	(local) government or RUD's/ omgevingsdienst

Dutch legislation and/or regulation on the efficient use of energy

The "Wet Milieubeheer" (= law on environment), has the possibility to obligate an energy audit and in July 2015 the EED is announced in Dutch legislation. Larger companies are obligated to perform an energy audit. You can find the announcement in www.overheid.nl or click in the digital report here.

There aren't any (national) standards for (efficient) steam boiler operation and design. Only for emissions (burners) there are standards. However the Dutch government has set up a support program, Long Term Agreements (Dutch: MeerJarenAfspraken or MJA) to stimulate and facilitate the rational use of energy (and therefor steam). The Dutch government is also stimulating investments with the EIA and MIA, respectively for investing in energy saving goods (or advice) and for investing in environmental saving goods (low NOx burners).

Check and audits

The following checks (audits) are obligatory in the field of steam:

SCIOS

The inspection is performed by a company that has a SCIOS certificate. SCIOS stands for Foundation Certification Inspection Maintenance Combustion (Activities Regulations, Article 3.7m, paragraph 4). The certificate shows the ability of the company and the employees.

SCIOS has set up a system for maintenance, regular inspections and inspection during commissioning (first individual inspection) and manages the quality system for inspection and maintenance. The Activities Decree is the framework for inspection and maintenance. The exact (technical) interpretation of the laws by SCIOS worked in various scopes for the different types of combustion plants, measurement and fuel lines.

Equivalence

Equivalence applies to countries within the EU. If a company from the EU carries out inspections in the Netherlands, first, the equivalence of quality of the country be demonstrated. The Accreditation Council for this is the designated authority.

Inspection Frequency

The inspection frequency depends on the nominal power and the used fuel. The inspection frequency is given in the table below (Activities Regulations, Article 3.7m, paragraphs 1 and 2).Inspection frequency

Table 0.1 Inspection frequency

▪ Fuel	▪ Nominal power	▪ Periodic inspection (at least)
▪ Gas	≤100 kW	-
	>100 kW	
▪ vast/liquid	<20 k	-
	20-100 kW	Once every 4 years
	>100 kW	Once every 2 years

Proper maintenance and inspection is the responsibility of the entrepreneur and expoitant. The Activities Decree gives a minimum frequency. Approve a higher frequency is based on ownership by the entrepreneur or operator. The latter is also often on the advice of the authority. The regulator can not maintain the frequency of the advice.

In short, the concrete requirements that operators will have to keep his (Activities Regulations, Article 3.7m):

- approve installation periodically, as an inspection reveals that maintenance is necessary that maintenance within two weeks after that inspection site,
- Only a SCIOS certified person carries out the inspection.

Periodically (preventive) maintenance in the Activities Decree prescribed. If an inspection reveals that maintenance is necessary (corrective), the entrepreneur needs to perform maintenance within two weeks. The SCIOS inspector gives no explanation of no objection before the corrective maintenance is performed (Activities Regulations, Article 3.7m, paragraph 5).

Initial special inspection

A requirement for a first special inspection (EBI) is not included in the Activities Decree. From the viewpoint of reducing the regulatory burden has been decided not to require the commissioning inspection by law. But in the SCIOS-system, it is necessary to carry out a report EBI because in the basic instructions are included for follow-up maintenance and -inspections. The supervisor can not sustain in the absence of a basic report. The operator may choose to re-let an EBI perform each test.

The first special inspection includes a check or a (new) device installed, including burned gas supply and fuel supply line is arranged and tuned according to the manufacturer's instructions and in accordance with the applicable safety and environmental requirements.

The regular checks can be devided in some main checks:

- Internal check on temperatures are performed by many enterprises.
- Obligatory external checks on emission and the integrity of pressure equipment
- Checks on energy saving opportunities where an agreement is made between government and business (association).

Tools, Training materials and Methodologies

See appendix A: Template for Tools and Methodologies.

See appendix B: Template for Information Sources and Training Materials.

Steam experts and expertise

The conservation and education/training of steam expertise isn’t well organized in The Netherlands. However there is a expert platform (www.stoomplatform.nl), and one supporting party in the Steam Up project (Econosto) gives the following courses, based on steam:

- Steam- and Codensate technology

  Steam is often regarded as outdated and associated with steam locomotives, among other things.

However, the reality is that more than 80% of production companies use steam as their main energy source. In addition to its application as a heat transport medium, steam is also used as a driver in thermal power plants. Steam is therefore definitely not obsolete, but also offers plenty of opportunities well into the 21st century!

- Engineering for steam and condensate technology

  Consultants and installers regularly deal with steam systems. Besides the correct installation of the fittings, the design of the steam pipeline network must also be optimal. In order to properly design this pipeline network, the engineers must have a good knowledge of the regulations, pipeline diameter calculations, points of attention in the assembly and selection of materials and fittings within the current laws and regulations.

- Boiler house management

  One of the most essential conditions for the continuity of the production process is the uninterrupted operation of the boiler plant. But faults in the energy production happen all too often due to sludge formation, corrosion and scale deposits. This results in substantial losses, which leads to high energy costs.

The experts on steam are mostly educated mechanical engineers and/ or industrial energy advisers. Industrial energy advisers are associated in the Federation of Energy Consultants (FedEC; www.fedec.nl) .

There is an education based on energy, PHOE (Post Higher energy Education) whereas students are educated on energy-use, renewables among others. They don't offer a study mainly based on steam.

Most companies don't have dedicated steam experts, but mostly maintenance and operational technicians have enough expertise and they are responsible for the operation of the steam boiler. Sometimes there're dedicated energy experts available in the companies, but this is rare. In most case energy efficiency is one of the responsibilities where the QUESH coordinator is involved in.

A well known complaint of people involved in the steam systems within an industrial enterprise is that they are lacking the time for efficiency studies of their installation. They only focus on obligations.

Expertise is mostly hired, using consultants.

Steam Experts in The Netherlands:

See Appendix C: Template for Steam Experts. Project Deliverable (2.3)

Key players in industrial steam

The key players in the field of steam use, technology (transfer) and expertise are:

5. **Industrial enterprises (NeM (boiler selling/building) a.o.)**
   Expertise in steam production, boilers and production equipment.

6. **Equipment suppliers (Econosto, burner suppliers)**
   Expertise in Steam (replacement) equipment like valves, steam traps, burners.
7. **Technology suppliers (Industrial Energy Experts (adviser/ engineering)**
   Concept engineering parties (new concepts), deliver not only production but focus also on steam use and demand. Focus on low Total Costs of Ownership and energy saving.
8. **Consultants (Industrial Energy Experts, KWA, Energy Technology services**
   Mostly independent consultants with a focus on energy saving.
9. **Sector organisations (NRK, VNCI, Vigef, COV, VPN)**
   Facilitating and information and a focus on jurisdictional issues.
10. **Expert platforms (Stoomplatform, FedEC)**
    Technical focus

Most key players have a dedicated role their field of expertise. Most of them have expertise in a part of the steam system (mostly production) whereas others are dedicated in facilitating energy saving opportunities or information.

Industrial Steam as an field of expertise is not very well known. Most expertise is in steam systems in general or – equipment –or saving energy (and steam among other forms of energy).

Most experts have an informing or stimulating role in the efficient use of industrial steam, but often their focus is different as said before.

Energy auditing practices

The MJA/ MEE dedicated companies are audited once every 4 years and monitored each year. The main reasons for enterprises to perform an energy audit are:

a. Legal obligations

b. Subsidised by government

c. To be able to cut energy costs

There are no other obligations for enterprises to perform energy audits other then:

- EED obligations
  > 250 fte
- National or local obligations
  Environmental law (Wet milieubeheer). Local governments may obligate an energy study if enterprise energy use is high enough.

The MJA/MEE reports (EEP’s) are registered from governmental side, but they are mostly confidential. The audit reports are followed up by a yearly monitoring and a obligation for implementation of energy management within the MJA dedicated companies. MEE dedicated companies mostly have ETS obligations.

Sometimes (50% of the cases) the implementation of energy saving (steam) measures are postponed, mostly caused by economical reasons. MJA/MEE dedicated companies still have better a better score in energy efficiency.

The interviews gave the following reasons that hinder the implementation of steam efficiency measures:

1. Energy efficiency is no legal issue. New burners are bought because of laws on emissons
2. No technical acceptance
3. Economic issues
4. Not well informed management (plant managers are busy with financial kPI's rather than durable).

The financial instruments and or programmes from national and/or local governments to support he rational use of energy and/or steam are well known (EIA, MIA, WBSO), and may overcome some of the hindering issues (but not all of them). One interviewed party who has to invest in new burners (before 2017) wasn't interested in the MIA finances which are still available in 2015. "We've enough other investments that aren't dealt with already and may also be granted for MIA-stimulation".

Tools, Training materials and Methodologies

See appendix A: Template for Tools and Methodologies.

See appendix B: Template for Information Sources and Training Materials.

Management practices

The most commonly used management systems in industrial enterprises in The Netherlands are ISO 9001 and 14001. The HACCP and the BRC standards are practices that are well implemented in the Food processing companies, and the companies that deliver to the food companies, these standards could accommodate energy efficiency policies in enterprises.

The management generally use the SPP (Single Payback Period) to assess investments, although TCO (Total Cost of Ownership) is more and more a known method, but mostly used by advisers and consultants and not embraced by the enterprises yet.

"We use the SPP because we can rely on the data, and therefor we can compare all investments in our company".

Note: With the reduction in steam we're talking about investments in cost reduction. Cost reduction is mostly realized in other than energy costs (Human resources, goods, logistics etc.) The companies rather invest in production capacity.

There is an organisational ERP system, which is implemented by Lutèce, see interviews (best practice) whereby organisational efficiency measures are quickly implemented.

Non Energy Benefits

Non-energy benefits are not reallyaccounted for when making investment decisions. Some measures hinder (continuity) rather than benefit. ARBO issues are sometimes important (for insulation dangerous hot systems)

Behaviour and energy efficiency

We have the following examples from where insights from behavioural science and change management were used to enhance energy efficiency in enterprises:

- Energy saving by behavioural changes – course – RVO – 2010 (building corporations, in Dutch)
- Workbook – “switch the lights” – workbook – RVO (“de knop om”, organizations)

The striking successes of the course and approaches are:

- A Systematic approach
- Plan do act check – approach
- Giving insights
- It is focussing on the main stakeholders (energy-users)
- Planning and monitoring

Failures however aren’t described, but normally a lack of management focus is killing the PDAC-circle.

B.7 SPAIN

1.1 Industrial enterprises

The number of industrial enterprises that are active in Spain is approximately 200.000 industrial companies, being the 80% of the turnover in manufacturing companies. We can give a division per sector considering energy intensive or non intensive industries:

- Intensives: Chemical, Construction and metals (70-75% of energy consumption)
- Non intensives: Transports, textile, food and paper and non metallic (5-15% of the energy consumption)
- Others (10-20%)

The estimated total energy use of the industrial sector in Spain is 25.328 kTep (in 2013) for non energy industrial sector.

(Source: www.ine.es)

Giving a short description of the type of industrial sectors active in Spain, there are two main industrial sectors namely intensive and non-intensive, 70-75% of the energy consumption corresponds to the first group and 5-10% to the second. The non-intensive industries with more potential (growth) are car and trucks and food and beverage. More than 90% of them are SMEs.

1.2. Installations

In Spain there are approximately 15.000 boilers in operation. Most of them are Fire tube boilers (about 95%). The fuel type used in the boilers is Natural Gas in most of the cases (90%), as well as fuel oil (8%) and biomass (2%).

These steam boilers have a life time higher than 20 years in the majority of the cases.

1.3. Sales figures and developing trends

About 100 steam boilers per year are being newly installed and the development trend is a growth. Therefore, the amount of steam boilers is growing. This growth can be due to the fact that there are many old boilers that need to be replaced as well as the improvements in the economy of some industries.

1.4. Energy use and potential

The total energy use for industrial steam production in Spain is not known yet or it is not possible to publicly access to it. Likewise, there is no information related with savings potential through studies, estimations or investigations. The estimated saving potential is a 20% of savings in steam energy consumption.

The sectors with the highest impact are the paper, food (included canned food), automotive and chemical industries, with the heat exchange processes and direct steam use accounting for the highest energy use.

Various promising steam saving measures can be taken, such us: heat recovery (exhaust, blowdown or condensate return), operation (operation pressure, stand still, idle mode (no demand)), control (automated blow down, exhaust oxygen,…), distribution (steam traps, control and design of heat exchangers,…), new equipments with lower steam consumption (high efficiency) or to change big steam boilers by smaller water boilers for specific consumers.

1.5. Sectors and processes (main industrial users)

The enterprises are organised over sectors by branch sectors and subsectors, being their main objective to support their associates. They contribute to the subject of increasing energy efficiency at enterprises by technical and financial support.

1.6. Legislation and regulation (steam and energy efficiency)

As regards European laws and regulations that are applicable in relation to steam systems there are boiler emissions related directives, as those related to burner's emissions and the possible "green bonus".

When it comes to steam production and steam use, the national legislation/regulation applied is:

- Pressurized vessels regulation (Real Decreto 2060/2008)
- Periodic inspections referred to in Article 9, Chapter II of the ITC EP-1 of R.D. 2060/2008
- Installation companies record.
- Order of March 17th, 1981, approving the Technical Instruction MIE- AP1of the Regulation of Pressurized Devices relating to "Boilers, economizers, preheaters, superheaters and reheaters "
- Order of March 28th, 1985, amending various articles of the Technical Instruction MIE-AP1 of the Pressure Equipment Regulations concerning boiler economizers, preheaters, superheaters and reheaters.

- Order of October 6th, 1980, approving the Technical Instruction MIE- AP2 approving of the Regulation on Pressure Equipment "Pipes for fluids relating to boilers".

When it comes to the efficient use of energy the national legislation/regulation applied is the *"Order of October 11, 1988, approving the Technical Instruction MIE- AP- 13of the Pressure Equipment Regulations concerning plate heat exchangers"*
There are no national standards for (efficient) steam boiler operation and design at the moment.

As support programs from national or local government to stimulate the rational use of energy and/or steam there are: the National Action Plan of Energy Efficiency (IDAE), H2020, Organizational innovation to improve energy efficiency in industry (EE-16-2015) and AXIS Lines.

As regards financial instruments and or programmes from national and/or local governments to support he rational use of energy and/or steam there are subsidies from the Ministry of Industry for Energy Efficiency and Energy Saving projects (IDAE).

1.7. Check and audits

Steam boilers are checked annually. What is checked is the emissions numbers (O2, NOx,…), the integrity of pressure equipment and a general visual inspection of losses, pipes and isolation, boiler water quality and composition, integrity of pressure equipment, cleaning and visual inspection of the smoke circuit and pressurized parts, operation elements and security, fire protection, gas circuit tightness.

1.8. Steam Experts and Expertise

In Spain there is not conservation and education/training of steam expertise organized.

The steam expertise level within industrial enterprises using steam is variable but it is practically inexistent. Enterprises usually do not have dedicated steam experts. The responsible for the steam installation in the industrial enterprises is the Plant Manager or Industrial Engineer.

The steam expertise and application is not outsourced in Spain and sometimes steam expertise is hired via energy auditors or consultants. There are not other means so far used by enterprises to maintain a proper level of steam expertise.

1.9. Key players in Industrial Steam (Force Field Analysis)

The key players in the field of steam use, technology (transfer) and expertise are: industrial enterprises, equipment suppliers, technology suppliers, contractors, consultants and energy auditors.

1.10. Energy Auditing Practises

Enterprises are regularly audited on energy use and efficiency according directive. The main reasons for an enterprise to perform an energy audit are: legal obligations, the possibility to cut energy costs, as part of their energy management system or as part of their sustainability policy.

In Spain we have relevant Directive as a national legal or regulatory framework to stimulate the rational use of energy.

Apart from the EED obligations there are not national or local obligations for enterprises to perform energy audits.

The organizations that have the obligations to perform energy audits are mainly big industries. Without the legal obligations to perform an audit, the enterprises are stimulated to perform audits by incentives, as subsidies.

The audit reports are registered from governmental side.

Aunque es dificil conocer el ratio de implementación de las mejoras, las experiencias indican que cada industria aplica entre un 20 y un 50% de las medidas propuestas. Los motivos por los cuales no se implementan las mejoras son de tipo económico, por no encajar en la planificación de las empresas el realizar todas las medidas simultáneamente o por falta de acuerdo de alguno de los directivos.

1.11. Management Practises

The management systems that are commonly used in industrial enterprises in Spain are: ISO 9001, ISO 14001, ISO 50001.

At the moment, we can not indicate the amount of certifications issued on the above mentioned standards. There are not any other management practises or standards where energy efficiency is addressed or that could accommodate energy efficiency policies in enterprises.

The financial financial (risk) assessment tools and methods that are generally used in industrial enterprises in Spain to assess investments are:

- NPV (Net Present Value)
- IRR (Internal Rate of Return)
- LCC (Life Cycle Costing)
- SPP (Single Payback Period)

1.12. Non Energy Benefits

When making investment decisions, non-energy benefits are accounted for improvements in the processes mainly, for instance, better regulation of the process speeding up of the processes, etc.

1.13. Behaviour and energy efficiency

Examples from Spain on studies, pilots programmes or practises where insights from behavioural science and change management were used to enhance energy efficiency in enterprises are not known.

8. Appendix C: Country Reports Associate Partners

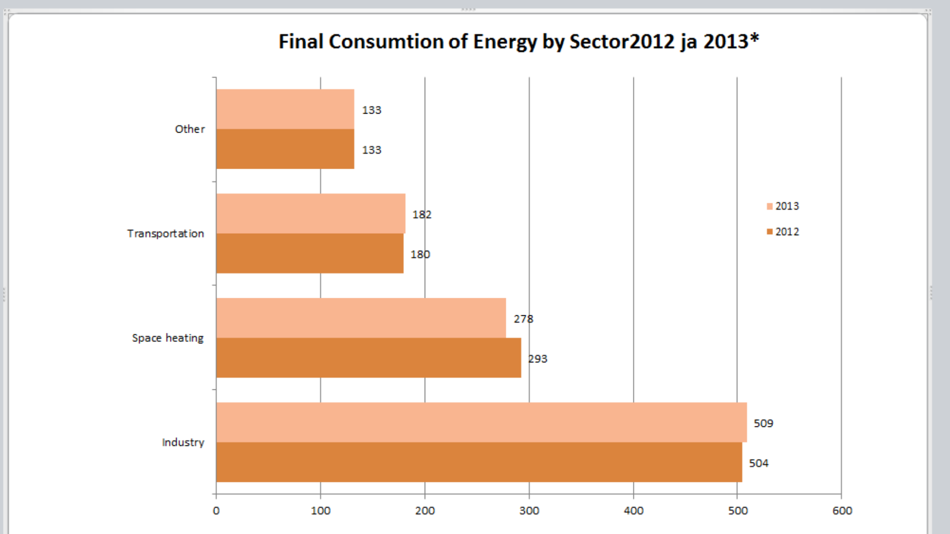
C.1 FINLAND

Industrial enterprises

1. How many industrial enterprises are active in your country? Please give a division per sector.

Industrial statistics, 2013	
Branch of industry (TOL 2008)	**Establishments**
Whole industry	**28 357**
Mining and quarrying	1 064
Manufacturing	24 054
Manufacture of food products	1 899
Manufacture of beverages	141
Manufacture of tobacco products	1
Manufacture of textiles	797
Manufacture of wearing apparel	1 034
Manufacture of leather and related products	198
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	2 246
Manufacture of paper and paper products	274
Printing and reproduction of recorded media	1 172
Manufacture of coke and refined petroleum products	32
Manufacture of chemicals and chemical products	411
Manufacture of basic pharmaceutical products and pharmaceutical preparations	42
Manufacture of rubber and plastic products	670
Manufacture of other non-metallic mineral products	1 046
Manufacture of basic metals	199
Manufacture of fabricated metal products, except machinery and equipment	5 022
Manufacture of computer, electronic and optical products	644
Manufacture of electrical equipment	492
Manufacture of machinery and equipment n.e.c.	1 693
Manufacture of motor vehicles, trailers and semi-trailers	281
Manufacture of other transport equipment	394
Manufacture of furniture	1 040
Other manufacturing	1 334
Repair and installation of machinery and equipment	2 992
Electricity, gas, steam and air conditioning supply	1 388
Water supply; sewerage, waste management and remediation activites	1 851

2. What is the (estimated) total energy use of the industrial sector in your country?



Source: Statistics Finland, PX-Web Database

Steam Installations

1. How many steam boilers are in operation in your country (with total installed capacity)?

   About 150 units with **average** 60 MW/unit.

Energy use and potential

1. What is the total energy use for industrial steam production in your country (PJ)? (source)
2. Is there any information of savings potential through studies, estimations, investigations,..?

   It has been only estimated in the project of *Energy efficiency of steam-condensate-systems,* that the total energy use for industrial steam production were about 60….65 TWh/a and the saving potential were about 3 %, in the case of Finland it were 1,9 TWh/a. Note, these are only very rough estimates.

Legislation and regulation (steam and energy efficiency)

1. What national legislation/regulation does apply when it comes to steam production and steam use?

   In Finland there is a law dealing with pressured devices and addition to this Pressure Equipment Directive (97/23/EY) has been implemented which give specific instructions.

   DIN standard 1942 (or a new version?) is used for planning and calculating the efficiency of a boiler.

   In addition to this there is the environmental law (implementation of IED directive) and some industrial safety regulations.

2. Are there any support programmes (e.g. government) to stimulate the rational use of energy/steam?

   The most important stimulating issue is the voluntary Energy efficiency agreement which covers also industrial power plants.

Check and audits

1. Are steam boilers checked on a regular basis and if yes on what frequencies and parameters?

   Yes, there are requirements for checking the boiler after fixed operating hours (20.000 h??). More information will be sent if needed. The companies have also rules of their own.

2. Can you indicate specific steam information (tools, practises, methodologies) in use in your country?

An energy audit model for power plants and specific audit model for steam-condensate-system are available. In addition to this there are guidelines for maintenance and measurement of steam-condensate system.

Steam Experts and Expertise

1. Who is responsible for the steam system in enterprises and what is his/her expertise?

   A machinery/steam boiler chief.

2. Can you indicate specific steam experts (persons, networks or platforms) in your country?

   Some names can be given:

   Mr. Pentti Arhippainen (Senior Corporate Advisor at Pohjolan Voima Oy)

   Mr. Juha Kouki (Production manager, at Pohjolan Voima Oy)

   Mr. Pekka Ahtila (Professor, Energy Economics at Aalto University)

Energy Auditing Practises

1. Are enterprises regularly audited on energy use and efficiency and are steam systems always included?

   There is an audit model for power plants. Audis are carried out according to the plans of the power plant. Some plants are auditing their plants on a regular basis.

2. Can you give an indication on the implementation rate of identified energy efficiency measures from audits?

   In an audit report all measures with payback time less than 10 years must be listed on a table with information if the measure will be implemented, is it already decided to be implemented, is it under consideration to be implemented or it will not be implemented at all.

   According to our experience about 50 % of heat savings measurers and about 60 % of electricity saving measures will be implemented.

   Those companies who have joined to the voluntary energy efficiency agreement report every year all measures, also those mentioned in the energy audit report. We do not calculate the implementation rate of the energy efficiency measures, only the number and savings of the measures.

3. What is currently hindering the implementation of steam/energy saving measures?

   Lack of information, time and money for investments.

4. Can you indicate specific energy auditing tools, practises and or methodologies and information in use in your country?

Additional information has already been sent.

Management Practises

1. What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?

   All are used but only few (number is not known at the moment)

2. Can you indicate the amount of ISO 50001 certifications issued?

   About 20-30 ?? ?

Non Energy Benefits

1. How are non-energy benefits accounted for when making investment decisions?

   Difficult to say without asking this from the companies.

Behaviour and energy efficiency

1. Do you have examples from your country on studies, pilots, or practises where insights from behavioural science and change management were used to enhance energy efficiency in industry?)

   Unfortunately no.

C.2 LUXEMBURG

Industrial enterprises

1. How many industrial enterprises are active in your country? Please give a division per sector.

We have 826 industrial enterprises.

Sectoral division:

Food industry (129)
Beverage (28)
Manufacture of tobacco products (1)
Textile Manufacturing (19)
Clothing industry (16)
Woodworking and manufacture of products of wood and cork, except furniture; manufacture of articles of straw and wickerwork (24)
Manufacture of paper and paper products (3)
Printing and reproduction of recorded media (94)
Chemical Industry (17)
Pharmaceutical (1)
Manufacture of rubber and plastic (28)
Manufacture of other non-metallic mineral products (36)
Metal (8)
Manufacture of fabricated metal products, except machinery and Equipment (193)
Manufacture of computer, electronic and optical products (12)
Manufacture of electrical equipment (14)
Manufacture of machinery and equipment (27)
Automotive Industry (11)
Manufacture of other transport equipment (2)
Manufacture of furniture (28)
Other manufacturing (81)
Repair and installation of machinery and equipment (54)
(Source: Statec, Répertoire systématique Les entreprises luxembourgeoises, 2014)

2. What is the (estimated) total energy use of the industrial sector in your country?

Energy consumption of Industries (buildings and processes) 6 322 GWh

(Source: Statec, A4100 Bilan énergétique par type de produits, 2013)

Steam Installations

1. How many steam boilers are in operation in your country (with total installed capacity)?
   > 12 boilers installed. No indication available about the installed capacity.

Energy use and potential

1. What is the total energy use for industrial steam production in your country (PJ)? (source)
   No indication available.
2. Is there any information of savings potential through studies, estimations, investigations,..?

Large energy consumers participate in the Voluntary Agreement. Therefore they carry out energy audits or implement energy management systems (maily ISO 50001)

Legislation and regulation (steam and energy efficiency)

1. What national legislation/regulation does apply when it comes to steam production and steam use?
   National Regulation sets minimum Energy efficiency and maximum emissions values for boilers.
2. Are there any support programmes (e.g. government) to stimulate the rational use of energy/steam?
   Government grants covered by European State Aid regulations
   Energy Efficiency Obligation Scheme (energy retailers are the Obliged Parties)

Check and audits

1. Are steam boilers checked on a regular basis and if yes on what frequencies and parameters?
   Gas-fired boilers: every 4 years : energy efficiency, combustion quality, safety requirements.
   Solid or liquid fuel boilers < 3MW: every 2 years: energy efficiency, combustion quality.
   Solid or liquid fuel boilers > 3MW: every year: energy efficiency, combustion quality.
2. Can you indicate specific steam information (tools, practises, methodologies) in use in your country?
   No indication available.

Steam Experts and Expertise

1. Who is responsible for the steam system in enterprises and what is his/her expertise?
   Answer is varying according to the size of the enterprise.
   This function is less and less carries out by in-house persons.
2. Can you indicate specific steam experts (persons, networks or platforms) in your country?
   The Learning factory www.learningfactory.lu

Energy Auditing Practises

1. Are enterprises regularly audited on energy use and efficiency and are steam systems always included?
   Voluntary agreement: Energy Audit every 6 years.
   Steam systems are significant energy consumers, thus always included.
2. Can you give an indication on the implementation rate of identified energy efficiency measures from audits?
   No indication available.
3. What is currently hindering the implementation of steam/energy saving measures?
   Low financial incentive
   Low cost of energy
   Lack of focus on energy efficiency
   Lack of technical competencies on energy efficiency in steam
   Low diffusion of total cost of ownership practice

4. Can you indicate specific energy auditing tools, practises and or methodologies and information in use in your country?

   No indication available.

Management Practises

1. What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?

   ISO 50001 ; ISO 14001; ISO 9001
2. Can you indicate the amount of ISO 50001 certifications issued?

Non Energy Benefits

1. How are non-energy benefits accounted for when making investment decisions?

   No indication available.

Behaviour and energy efficiency

1. Do you have examples from your country on studies, pilots, or practises where insights from behavioural science and change management were used to enhance energy efficiency in industry?)

   No

C.3 NORWAY

Industrial enterprises

1. How many industrial enterprises are active in your country? Please give a division per sector.

The total number runs up to about 20 000, but only around 1200 use more than 1 GWh energy per year.

The table under is based on the reporting from 2011 but gives a good indication. 1600-2000 enterprises report their energy consumption to the Norwegian statistics bureau every year.

	More than 50 GWh	10-50 GWh	5-10 GWh	1-5 GWh	Less than 1 GWh	Number of ent.	Energy use GWh
Chemical products	26	16	9	4	10	65	17104
Metal	23	12	8	9	24	76	29467
Pulp&paper	15	3	1	9	8	36	9678
Non metal material	14	10	17	71	81	193	3462
Food	11	95	75	183	147	511	3872
Wood	6	28	8	40	52	134	1427
Mining	4			3		7	640
Mining others	3	13	16	56	21	109	717
Coal and refining	2					2	7831
Oter transport	1	10	10	21	40	82	392
Vehicles etc	1	4	4	8	13	30	223
Metalproducts	1	4	12	107	178	302	729
Pharmaseutical	1	5	3	1	1	11	161
Textiles		1	4	21	82	108	94
Repair and install		3	6	11	72	92	143
Other industry		2		9	48	59	56
Furniture		1	2	21	32	56	96

Machinery		7	4	53	119	183	347
Electrical equipm		3	4	19	22	48	158
Computer, opticals ets		1	3	14	15	33	78
Rubber and plastics		8	12	34	31	85	341
Publishing		4	3	22	36	65	148
Total energyuse	68,9 TWh	4,9 TWh	1,34 TWh	1,68 TWh	0,42 TWh		
Total number of enterprices	108	230	201	716	1032		

2. What is the (estimated) total energy use of the industrial sector in your country?

According to the statistics collected by the national bureau of statistics the Norwegian industry used 76 TWh in 2014. This is based on reports from about 1600 enterprises. 100 of the reporting enterprises use more than 50 GWh/year and these 100 together use approximately 80% of the energy in the industry

Steam Installations

1. How many steam boilers are in operation in your country (with total installed capacity)?

Energy use and potential

1. What is the total energy use for industrial steam production in your country (PJ)? (source)
2. Is there any information of savings potential through studies, estimations, investigations,..?

We have no studies of the potentials of energy savings in steam boilers, but a study of the energy efficiency potentials don by McKinsey in 2009 indicated a overall saving potential for the Norwegian industry of 27-30%

Legislation and regulation (steam and energy efficiency)

1. What national legislation/regulation does apply when it comes to steam production and steam use?

Design, manufacturing and inspection of the boiler pressure part shall comply with the requirements of EN standard. Were the Pressure Equipment Directive (97/23/EC) is applicable to components; the components shall conform to the directive and be CE marked when required.

After completion of the pressure part assembly on site the Notified Body shall prepare a Certificate of Conformity for the pressure part.

2. Are there any support programmes (e.g. government) to stimulate the rational use of energy/steam?

Enova has several investment aid programs targeting the industry and the support will also include possible energy savings projects in steam boilers.

Check and audits

1. Are steam boilers checked on a regular basis and if yes on what frequencies and parameters?

Answer: Steam boilers checked on a regular basis every 5 year by a Notified Body. The following activities will typical be included in control:

• Internal and external inspection of pressure parts wherever possible

• Control of the boiler safety system

• Checking the safety valve (s)

• Pressure testing (optional when other control methods are equal)

• Non destructive examination when deemed necessary

• Function check / test to ensure that equipment and facilities functions as specified and that all safety and control devices functioning as intended

• Review of documentation for repairs, alterations and checks in the period

2. Can you indicate specific steam information (tools, practises, methodologies) in use in your country?

Steam Experts and Expertise

1. Who is responsible for the steam system in enterprises and what is his/her expertise?

Responsible for operation of the boiler need to have experience and boiler operator courses that meet all government requirements.

2. Can you indicate specific steam experts (persons, networks or platforms) in your country?

Consulting Company as Norsk Energi is a typical expert on industrial boiler systems in Norway and use of steam in process industries.

Energy Auditing Practises

Not applicable In Norway – we have not taken the energy efficiency directive yet and have not used energy audits as a tool before

Management Practises

1. What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?

ISO 9001, ISO 14001 and ISO 50001 are commonly used

2. Can you indicate the amount of ISO 50001 certifications issued?

15-20 enterprices (14 in the summer of 2014. We have tried to get updated information from ISO but they seem to have lost track of the numbers – earlier they could send us lists on a regular basis)

Non Energy Benefits

1. How are non-energy benefits accounted for when making investment decisions?

Behaviour and energy efficiency

1. Do you have examples from your country on studies, pilots, or practises where insights from behavioural science and change management were used to enhance energy efficiency in industry?)

C.4 PORTUGAL

Industrial enterprises

1. How many industrial enterprises are active in your country? Please give a division per sector.
   According to the most recent statistics, referred to the year 2013, the Portuguese Industry accounted in that year a total of 67.580 enterprises, from which 1.157 belonging to the Mining Industry and 66.423 belonging to the Manufacturing Industry.

2. What is the (estimated) total energy use of the industrial sector in your country?
   The total energy use of the Portuguese Industry is 185,9 PJ (2013 data), with the following breakdown by industrial sectors:

Industrial Sector	Final energy consumption (TJ)
Mining Industry	**5.051**
Manufacturing Industry	**180.865**
Food & Drinks and Tobacco Industries	18.162
Textiles Industries	10.413
Pulp and Paper Industries	58.738
Chemicals, Rubber and Plastics Industries	21.499
Non-metallic Mineral Products Industries	44.651
Basic Metallurgy Industries	8.568
Clothing, Footwear and Leather Industries	1.877
Wood Industries	4.187
Metallics, Electrical and Mechanical Industries	8.997
Other Industries	3.773
TOTAL	**185.917**

(Source: Provisional Energy Balance of 2013, from DGEG – Portuguese Directorate-General for Energy and Geology)

Steam Installations

1. How many steam boilers are in operation in your country (with total installed capacity)?
   Not available in Portugal this type of information. Even boilers suppliers and other entities linked to the steam market, like Spirax Sarco, do not know the total figures.

Energy use and potential

1. What is the total energy use for industrial steam production in your country (PJ)? (source)
   It must be about 20% of the total energy consumption of the Portuguese Industry, i.e. 37,2 PJ (Source: ADENE's estimation).

2. Is there any information of savings potential through studies, estimations, investigations,..?
   Typically it is possible to obtain energy savings **up to about 10%**, with improvements in the design and operation of the steam boilers, as well as in the correspondent steam and condensate distribution networks. These are the results of several energy audits carried out in the Portuguese Industry, the most part within the SGCIE – Intensive Energy Consumptions Management System regulation that is managed by ADENE and DGEG – Portuguese Directorate-General for Energy and Geology, and a specific study in this area leaded by ADENE and developed at 2010 with the support of Spirax Sarco and three of the main Portuguese steam boilers suppliers.

According to this study, the energy savings potential identified in a sample of 45 industrial companies and 63 steam boilers had the following breakdown by categories of measures:

Type of Measure	Representativity in terms of % of Total Energy Savings Potential identified in the Study
Procedures optimisation in steam boiler - Combustion efficiency improvement & Heat transfer surfaces cleaning	24,8%
Procedures optimisation in steam boiler - Improvement of boiler feedwater treatment (including boiler blowdown optimisation)	1,2%
Procedures optimisation in steam boiler and steam users - Improvement of equipments control and/or maintenance	12,0%
Implementation of an automatic system of oxygen trim control in the boiler	16,8%
Installation or improvement of thermal insulations - in fuel oil tanks, condensates tanks, boilers feedwater tanks, steam/condensates pipes, etc.	2,5%
Boiler blowdown heat recovery	2,3%
Heat recovery from boiler flue gases - installation of economisers and/or combustion air pre-heaters	40,1%
Boilers replacement	0,3%
Other measures	0,1%
TOTAL	**100,0%**

It was shown in that study that the total investment cost associated to the implementation of all measures had an average payback period of 1,2 years, with the particularity that almost 60% of the savings were possible through measures with a payback of less than 1 year.

The "good housekeeping measures" (not involving any investment, or with a minimum investment cost of less than 5.000 EUR) were responsible by more than ¼ of the savings, and the measures involving "average investments" (between 5.000 and 75.000 EUR) and "high investments" (higher than 75.000 EUR) would lead, respectively, to about 56% and 18% of the identified savings.

From the above mentioned types of measures, it should be highlighted the *procedures optimisation* (with particular focus on the boiler combustion efficiency improvement and/or heat transfer surfaces cleaning) and the *heat recovery* (with special focus on the heat recovery from boiler flue gases, involving installation of economisers to increase the boiler feedwater temperature) that were responsible by 80% of the energy savings.

Legislation and regulation (steam and energy efficiency)

1. What national legislation/regulation does apply when it comes to steam production and steam use?

   The main Portuguese legislation in this field comprises a Decree-Law (No. 97/2000, of 25 May), that regulates the requirements for equipment under pressure and defines the safety conditions for installation, operation, repair and modification of such equipments, and the Order no. 22 332/2001 of 30 October, related to that Decree-Law, that defines the ITC rules (Complementary Technical Instructions) applicable to steam boilers and other similar equipment.

2. Are there any support programmes (e.g. government) to stimulate the rational use of energy/steam?

   In Portugal, in terms of support programmes, it has not been common the existence of specific supports for the rational use of steam, but instead of that the existence of supports for energy efficiency improvement / RUE measures in general terms, in which may be included measures in that area. It is what happens with the present Energy Efficiency Fund (FEE), linked to the mandatory SGCIE regulation that must be accomplished by the Operators of plants with a total energy consumption equal to or higher than 500 toe/year, in which presently there is support for several areas, including for measures related to combustion systems, particularly of the following types:

   - Installation of economisers and/or air combustion pre-heaters in boilers;
   - Use of more efficient thermal insulation in pipes and accessories (valves, flanges, …) of hot fluids distribution networks (steam, hot water, etc.); and,
   - Installation of automatic control systems for the oxygen content in boilers flue gases.

   The incentive for enterprises, through FEE, for these types of energy savings measures is a 25% co-financing of the eligible investment costs, with a maximum support of 65.000 EUR.

Check and audits

1. Are steam boilers checked on a regular basis and if yes on what frequencies and parameters?

   Yes, the steam boilers are checked on a regular basis, according to the above mentioned legislation. This is done at the time of the approval of the installation, at the time of the operation renewal authorization (each 5 years), and also for intercalary inspections (each 2 years and a half, or less, in cases of abnormal situations involving safety risks).

   These technical inspections, carried out by DRE - Regional Directions of the Economy Ministry (or by other entities contracted by DRE), usually include pressure tests of the equipment and other tests or verification procedures related to mechanical construction aspects (like thickness control in boilers), control and safety systems (valves, etc.), degradation status of several components and operation. This analysis does not oblige the carrying out of combustion tests in the boilers.

2. Can you indicate specific steam information (tools, practises, methodologies) in use in your country?

   We have not information about specific tools, practises or methodologies in this field, but there are brochures and specific tools provided by manufacturers.

Steam Experts and Expertise

1. Who is responsible for the steam system in enterprises and what is his/her expertise?

   Usually it is someone belonging to the Maintenance Department or to the Utilities Department or even to an Energy Management Department (more common in large enterprises), with a background of Engineering. But is also usual in SMEs to find persons that are not engineers and that have not the adequate qualifications for it.

2. Can you indicate specific steam experts (persons, networks or platforms) in your country?

   Mr. Fernando Mouta, Technical Manager of the Portuguese branch of Spirax Sarco.

<u>Energy Auditing Practises</u>

1. Are enterprises regularly audited on energy use and efficiency and are steam systems always included?

   As it was already explained, in Portugal there is a mandatory regulation (SGCIE – Intensive Energy Consumptions Management System), whose aim is to promote energy efficiency and to monitor the energy consumptions of intensive energy consuming installations. It applies mainly to industry sector and is applicable to individual plants with an energy consumption ≥ 500 toe/year. The Operators of the plants covered by SGCIE are obliged to undertake a comprehensive energy audit (to be done by Technician recognized/accredited by DGEG) and to submit an Energy Consumption Rationalization Plan (PREn) with the Energy Audit Report, for DGEG’s approval. The PREn’s duration is 6 or 8 years, depending on the level of yearly energy consumption of the plant, which means that the energy audits have a frequency of 6 or 8 years per plant. After completing a cycle “Energy Audit + PREn”, a new one must start.

   As these PREn’s are done in terms of 3 energy efficiency indicators – Specific Energy Consumption, Energy Intensity and Carbon Intensity, and there are targets to accomplish – 6% or 4% reductions of the values of the two first indicators at the end of the PREn period compared to the values of those indicators at a reference year, this means that in the energy audits that are the basis for the PREn’s it should be identified a sufficient number of energy saving measures so that those targets/reductions may be achieved. Therefore, the energy audits must be as much as possible comprehensive / complete, and this is contemplated in the SGCIE legislation in which are mentioned the following points:

   - “The energy audit must be a detailed survey of all aspects related to the use of energy, or that in a certain way contribute for the characterization of the energy fluxes. It should aim the energy characterization of the existing equipment and systems in the plant and the identification of measures with technical and economic viability that are possible to be implemented, with the purpose of increasing the energy efficiency and to reduce energy costs. The audit must focus on the design and state of the installations, and should be compiled all data needed for the preparation of PREn and subsequent verification of it”.
   - “The energy audit should quantify the energy consumptions by global plant and by main sections and/or equipment. Apart visual inspection of energy consuming equipment / systems, it should be complemented by the necessary measurements. It should also be clarified how the energy is transformed and the correspondent costs”.

- "The survey and detailed characterization should cover the major energy consuming equipment, mainly those ones that are more representative in terms of installed electrical and thermal power".
- "Concerning boilers, its thermal efficiency should be determined (by direct method or losses method)".
- "The situation / conservation of the energy transport and distribution networks should also be analysed".
- "Also the verification of the good operation of control and regulation systems of the energy conversion and user equipment should be done".
- "The audit must include the carrying out of mass and energy balances in the main equipment that consumes thermal energy".
- "It must be identified and quantified the areas in which is possible to save energy, with viable investments, as a result of the encountered situations/detected anomalies and measurements carried out".

Therefore, it is implicit from these guidelines that steam systems must be analysed within the scope of the SGCIE audits.

2. Can you give an indication on the implementation rate of identified energy efficiency measures from audits?

   More than 90%, according to the results of SGCIE. Even in cases in which Operators quit of some measures that were foreseen in PREn's, they are obliged to find/implement alternative measures with equivalent savings, and only in a few cases this doesn't happen.

3. What is currently hindering the implementation of steam/energy saving measures?

   Mainly lack of information and unawareness of people that deal with these systems, about the real benefits of simple measures that could lead to relevant savings with short payback periods.

3. Can you indicate specific energy auditing tools, practises and or methodologies and information in use in your country?

   ADENE has produced in the past a document regarding audits.

<u>Management Practises</u>

1. What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?

   The most common are the ISO 9001 and ISO 14001, but we also find in several enterprises some of the other management systems that you point, like ISO 22000 and OHSAS 18001, or other specific standards, depending on the industry sector. Many of these management systems that we find only in a few enterprises are required by law or by their clients, particularly if we are talking about specific industrial sectors (as the Food sector, for instance) or types of enterprises (more usual in those ones with exporting vocation).

2. Can you indicate the amount of ISO 50001 certifications issued?

We have not precise figures, but as this is a recent management system in Portugal, with not more than 2 years, from what we have seen and heard it should be less than 20 enterprises in the whole country that have already adopted this management system. There are several entities giving training courses about this ISO 50001 related to Energy Management Systems, and focusing the qualification of auditors for its implementation, and we also find some industrial enterprises showing interest to know more about this ISO, but in reality only a few ones have started procedures for its application.

Non Energy Benefits

1. How are non-energy benefits accounted for when making investment decisions?

   When making investment decisions non-energy benefits are accounted for social responsibility commitments or because emissions targets have to be fulfilled such in the ETS (Emission Trading System) companies.

Behaviour and energy efficiency

1. Do you have examples from your country on studies, pilots, or practises where insights from behavioural science and change management were used to enhance energy efficiency in industry?)

According to the information obtained from around 1000 energy audits, behavioural type measures represent around 2% of the energy efficiency potential

C.5 SWEDEN

Industrial enterprises

1. How many industrial enterprises are active in your country? Please give a division per sector.

In total there are 52 590 industrial enterprises (Nace 05-33) in Sweden (2014). By sector these are distributed as follow:
05-09, Mining & Minerals: 732 enterprises
10-12, Food Industry: 3844 enterprises
13-15; Textile: 4621 enterprises
16, Wood: 5226 enterprises
17, Pulp & Paper: 366 enterprises
18, Graphic industry: 2940 enterprises
20-21: 898 enterprises
22, Rubber: 1431 enterprises
23, Other non metal: 1975 enterprises
24, Steel & Metal: 381 enterprises
25-31: 19664 enterprises
32-33: 10472 enterprises
(Source: FDB/Statistical Business Register, Statistics Sweden)

2. What is the (estimated) total energy use of the industrial sector in your country?

Total energy use in the Swedish manufacturing industry (nace 05-33) was 142,7 TWh in 2013. By sector this was divided as follows:
Pulp and paper: 73,9 TWh
Steel, iron and metal: 22,5 TWh
Chemical industries: 12,7 TWh
Manufacturing: 8 TWh
Mining 5,7 TWh
Food, bevarages and tobacco:. 5,0 TWh
Non metallic minerals: 4,4 TWh
Wood and wood products: 7,4 TWh
Other industries: 3,1 TWh
The total energy use was divided on the following energy carriers:
Biofuels: 54,6 TWh
Coal, coke: 14,2 TWh
Petroleum fuels: 10,1 TWh
Natural gas: 3,6 TWh
Other fuels: 5,1 TWh
District heating: 4,2 TWh
Electricity: 50,9 TWh
(Source: Energy in Sweden 2015 – facts and figures, Swedish Energy Agency)

Steam Installations

1. How many steam boilers are in operation in your country (with total installed capacity)?

We have no statistics or information on number of steam boilers installed or in operation in Swedish manufacturing industries

No statistic available. There are estimations from different sources. Tital number of steam boilers in distric heating is about 3500, size 1-5 MW: 2000, 5-10MW: 1000 and 500>10MW (30 in 100-200
The total number of boilers i district heating is about 3500, 2000 pannor in size 1-5 MW and around 1000 size 5-10 MW. About 500 larger than 10 MW. NO_x-register says about 250 boilers with>25 GWh. Info about industrial boilers with energy production> 25 GWh is found in NO_x-registet: about 160 . In addition about 40 soda boilers in pulp&paper industry.
Table below
Kraft och värme: Combined heat &power
Kemi – Chemistry
Livsmedel – Food
Massa &Papper – Pulp&Paper

Tabell 1. Pannor med energiproduktion över 25 GWh år 2003 exklusive sodapannor.

Antal pannor fördelade efter panneffekt	4-10 MW	11-50 MW	51-100 MW	101-200 MW	> 200 MW
Kraft- och värme	61	110	45	26	13
Kemiindustrin	3	18	9		
Livsmedelsindustrin	1	15	1		
Massa- och pappersindustrin	7	24	24	9	1
Metallindustrin		4		1	
Träindustrin	24	17			
Totalt	96	188	79	36	14

Trä - Wood

Rökgaskondensering – Flue gas condensation?
To enhance COP
Translatio: Do you need?
Rökgaskondensering är en tämligen utbredd teknik för att öka verkningsgraden i förbränningsanläggningar. Tekniken kan användas på i stort sett alla bränslen som är fuktiga och/eller innehåller hög andel väte som kan bilda vattenånga vid förbränningen (t ex naturgas). På många anläggningar som eldar fuktiga biobränslen och torv finns en rökgaskondensor installerad. Antalet anläggningar med rökgaskondensorer som är kopplade till fjärrvärmesystem beräknas uppgå till ett hundratal (2004), varav ett fåtal på naturgaseldade pannor. Med dagens energipriser har det blivit standard att förse nya anläggningar som uppförs för förbränning av fuktiga och/eller väterika bränslen med rökgaskondensering, även på mindre anläggningar.
Bland befintliga fjärrvärmepannor kan rökgaskondenseringen sägas vara i stort sett fullt utbyggd där det i dag är lönsamt. En potential som har börjat utnyttjas på senare år är industriell rökgaskondensering där kondensvärmen utnyttjas i närliggande fjärrvärmenät.

Energy use and potential

1. What is the total energy use for industrial steam production in your country (PJ)? (source)

We do not have any statistics on how much of the fuels in industries that are used for steam production. However, for many sectors a large part of the fuel is used in processes where steam is produced. 79% of the fuels I Pulp&paper industry are renewable, non-fossile. Heat productions in Pulp&Paper is about 45 TWh/year

2. Is there any information of savings potential through studies, estimations, investigations,..?

   I think there is some scattered information but I havn't found it yet. An estimation in Pulp & paper is 20% potential. This figure can change in case there is conversion to renewable fuels that often are not dry

Legislation and regulation (steam and energy efficiency)

1. What national legislation/regulation does apply when it comes to steam production and steam use?
   There is the Swedish system parallel to OHSAS 18001:
   AFS 2002:01 - Användning av trycksatta anordningar – Use of pressurized equipment
2. Are there any support programmes (e.g. government) to stimulate the rational use of energy/steam? Information program to covert from fossile fuels to renewables2013 (year?)

   Energy audit law, energy audit financial support for SMEs, Hopefully a suggestion in autumn budget for energy efficiency in energy intensive and large industry

Check and audits

1. Are steam boilers checked on a regular basis and if yes on what frequencies and parameters?
   Checked for safety reasons: AFS 2002:01 - Användning av trycksatta anordningar where competence and educational requirements are included
2. Can you indicate specific steam information (tools, practises, methodologies) in use in your country?
   I do not know yet

Steam Experts and Expertise

1. Who is responsible for the steam system in enterprises and what is his/her expertise?
   Regulated in AFS 2002:1
2. Can you indicate specific steam experts (persons, networks or platforms) in your country?
   There are requirements for education/training/knowledge and that the boiler of a certain size must not be left unattended

Energy Auditing Practises

1. Are enterprises regularly audited on energy use and efficiency and are steam systems always included?

About 200 sites in former PFE-program have ISO 50 001 and are updating audits on a regular bases, at least every 3rd year. Steam systems are included unless steam is bought from external supplier

2. Can you give an indication on the implementation rate of identified energy efficiency measures from audits?
   Heat efficiency measures have a large potential in the energy intensive industries and are being performed on a regular basis
3. What is currently hindering the implementation of steam/energy saving measures?
   - Other priorities
   - Lack of knowledge and measurements
3. Can you indicate specific energy auditing tools, practises and or methodologies and information in use in your country?
   http://www.nordicenergyaudit.se/en

Management Practises

1. What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?

   9001, OHSAS 18 001/or AFS and 14 001 are common. 50 001 covers 70% of the energy use in the industrial sector
2. Can you indicate the amount of ISO 50001 certifications issued?
   About 200 sites are certified (ISO 50 001) some of them in the same company

Non Energy Benefits

1. How are non-energy benefits accounted for when making investment decisions?
   Maintenance costs are sometimes included, and productivity if obvious

Behaviour and energy efficiency

1. Do you have examples from your country on studies, pilots, or practises where insights from behavioural science and change management were used to enhance energy efficiency in industry?)
   PFE program did put energy om the agenda both for staff and management
   Energy management system light is starting to spread in SMEs

C.6 SWITSERLAND

Industrial enterprises

1. How many industrial enterprises are active in your country? Please give a division per sector.
   Data for 2012
   Sektor 1: 56'732 enterprises
   Sektor 2: 90'042 enterprises –> for more details see Link
   Sektor 3: 411'055 enterprises

2. What is the (estimated) total energy use of the industrial sector in your country?
   Year 2013: Total 164'460 TJ (18.4%)
   including internal transport and all energy sources (electricity, coal, natural gas, fossils, renewables, distance heating, industrial waste heat)

   Source: Endenergieverbrauch nach Verbrauchergruppen (je-d-08.03.02.01) Bundesamt für Energie BFE

Steam Installations

1. How many steam boilers are in operation in your country (with total installed capacity)?
   ?
   We don't know the number. 55 enterprices have an installed capacity of > 20 MW. These are the enterprises that have to fullfill the regulations of the ETS (Emission Trading System).

Energy use and potential

1. What is the total energy use for industrial steam production in your country (PJ)? (source)
   ?

   No date is available on the steam production. What is available are the energy consumption based on usage:

ıdustriesektor: Entwicklung des Endenergieverbrauchs
000 bis 2013 nach Verwendungszwecken, in PJ

		Year 2013	
aumwärme	Heating	22.2	PJ
/armwasser	Hot water	3.7	PJ
rozesswärme	Prozess heating	86.6	PJ
eleuchtung	lighning	6.4	PJ
lima, Lüftung, HT	air conditioning, ventilation	1.1	PJ
‌ꝛK, Unterhaltung	Information & communication	0.8	PJ
ntriebe, Prozesse	Motors and processes	39.7	PJ
ɔnstige	others	6.8	PJ
otal ndenergieverbrauch	total endenergieconsumption	167.3	PJ

Source: Analyse des schweizerischen Energieverbrauchs 2000 – 2013 nach Verwendungszwecken
http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=de&name=de_523528791.pdf

2. Is there any information of savings potential through studies, estimations, investigations,..?

Legislation and regulation (steam and energy efficiency)

1. What national legislation/regulation does apply when it comes to steam production and steam use?
SVTI (Swiss Association for Technical Inspections) is in charge for the testing of pressure vessels in general and steam boilers. The regulations are not available in English but here the regulations in German and French:
http://www.svti.ch/de/kesselinspektorat/svti-regelwerk/

2. Are there any support programmes (e.g. government) to stimulate the rational use of energy/steam?
There are now specific system for steam but for general efficiency increase in industrial enterprises and services (sector 2 and 3) in place. Long term agreements for 10 years are negotiated with the enterprises. As incentive, the refund of the CO2 tax and a tax on electricity is used to ensure that the targets were reached from year to year. The system is covering the 2'000 biggest eneterprises in Switzerland that are responsible for 1/3rd of the total energy consumption of sector 2 and 3.

Check and audits

1. Are steam boilers checked on a regular basis and if yes on what frequencies and parameters?
Yes, depending on the category of the pressure vessel and the type of testing applicable, the period is between 2 and 12 year. The related document can be found here:

804	Druckbehälter Periodische Prüfungen	teilweise	Druckgeräteverwendungs-verordnung SR 832.312.12 / EKAS Richtlinie 6516	Download SVTI-Vorschrift 804 (eingefroren) Version française

2. Can you indicate specific steam information (tools, practises, methodologies) in use in your country?
See document mentioned under 1.

Steam Experts and Expertise

1. Who is responsible for the steam system in enterprises and what is his/her expertise?
No specific qualification but regulation for initial and periodic testing.
2. Can you indicate specific steam experts (persons, networks or platforms) in your country?

Please refer to SVTI (www.svti.ch/en).

Energy Auditing Practises

1. Are enterprises regularly audited on energy use and efficiency and are steam systems always included?
   Yes, is part of long term agreements.
2. Can you give an indication on the implementation rate of identified energy efficiency measures from audits?
   The system requires that all measures with a certain payback (< 4 years for process measure, < 8 years for infrastructure measures) are obliged to be implemented. Otherways the the refund of the taxes is jeopardized an a penalty can be due.
3. What is currently hindering the implementation of steam/energy saving measures?
   Partly the to high payback.
4. Can you indicate specific energy auditing tools, practises and or methodologies and information in use in your country?
   We are working with two energy agencies that have their own tools: please refer to www.enaw.ch or to www.act-schweiz.ch.

Management Practises

1. What management systems are commonly used in industrial enterprises in your country (ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…)?
   These managementsystems are used in the big enterprise widely. Only ISO 50001 is today not yet popular.
2. Can you indicate the amount of ISO 50001 certifications issued?
   No information available.

Non Energy Benefits

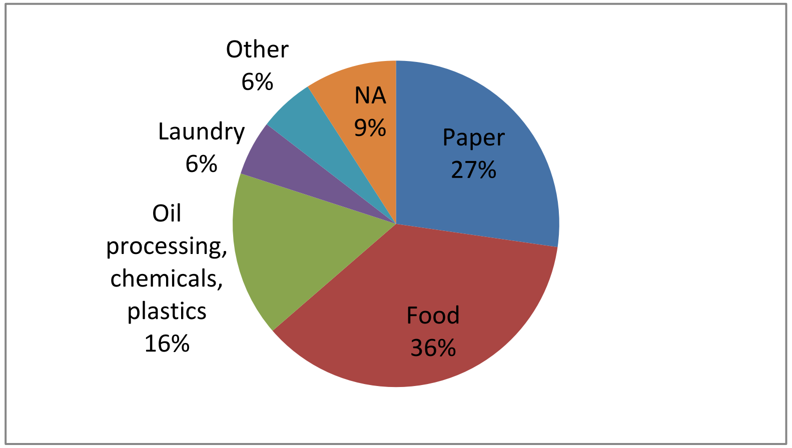
1. How are non-energy benefits accounted for when making investment decisions?
   They are not systematically considered.

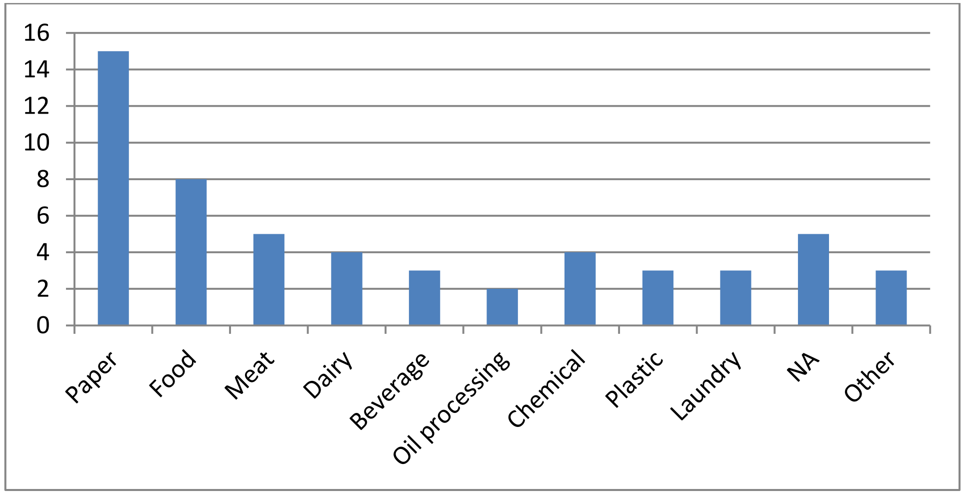
Behaviour and energy efficiency

1. Do you have examples from your country on studies, pilots, or practises where insights from behavioural science and change management were used to enhance energy efficiency in industry?)
   In general, the system is based on an technical approach and there is no focus on behavioural changes.

9. Appendix D: Results Enterprises Interviews

Sectors

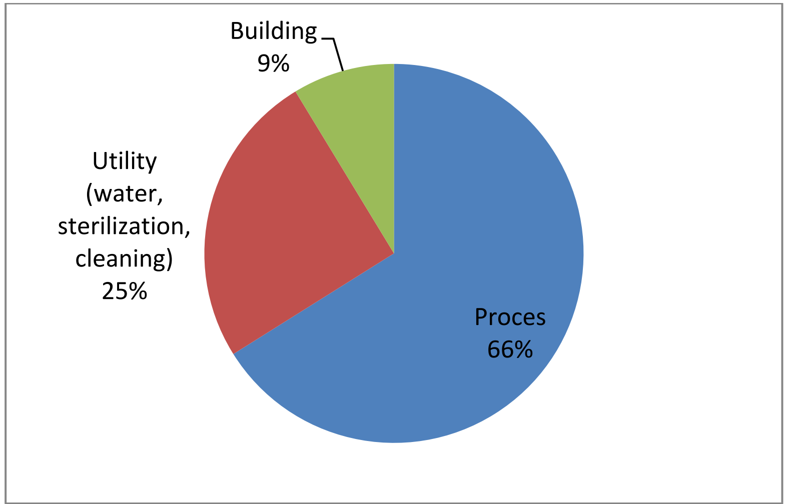


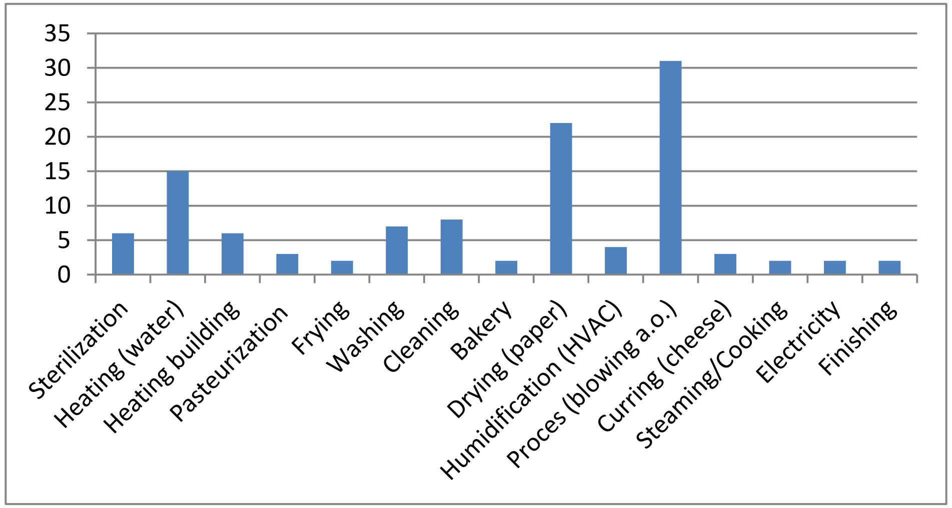


Steam Use and Operation

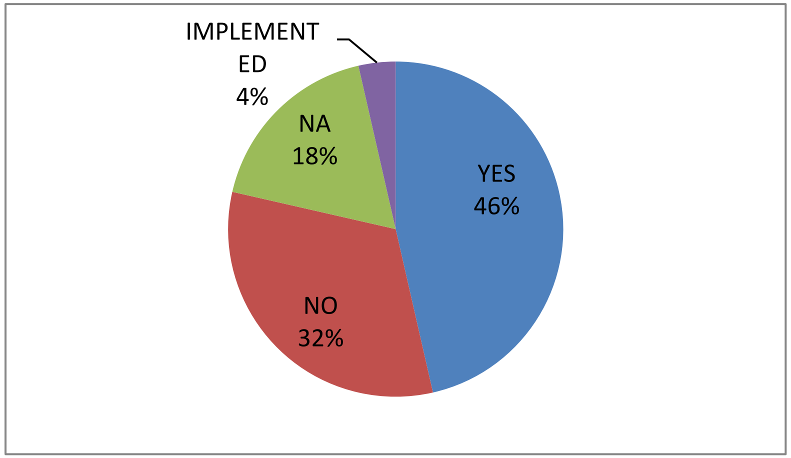
Steam use in general (Why is it used?)

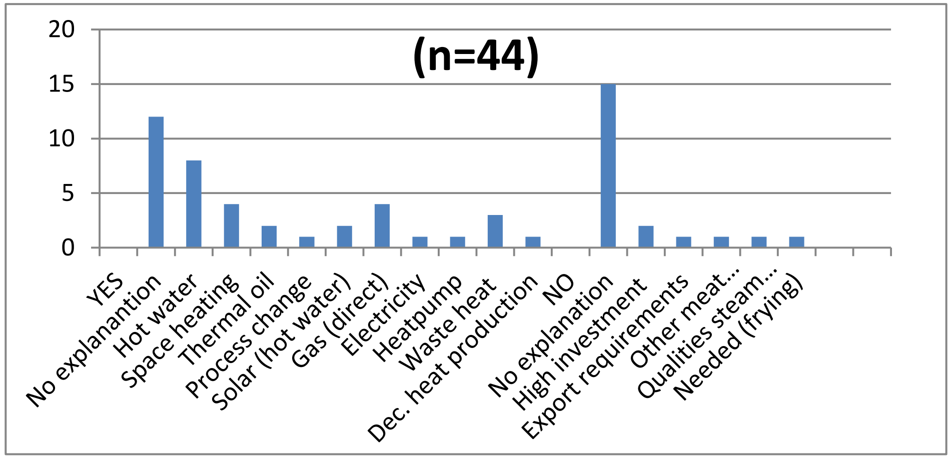
1. For what purpose(s) is steam being used?





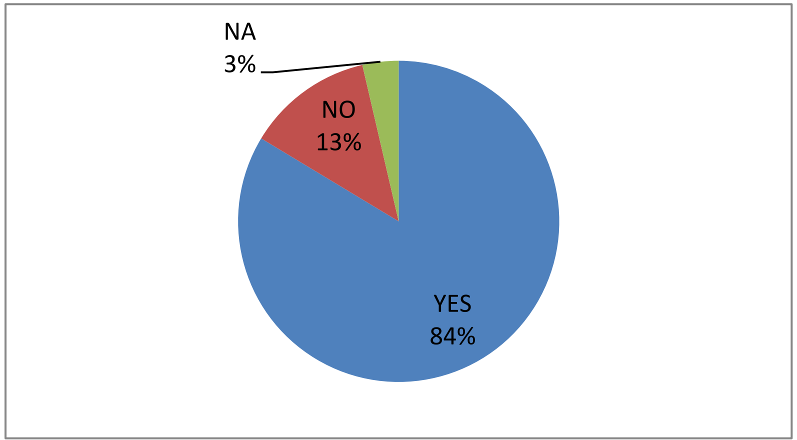
2. Have alternatives for steam being assessed?

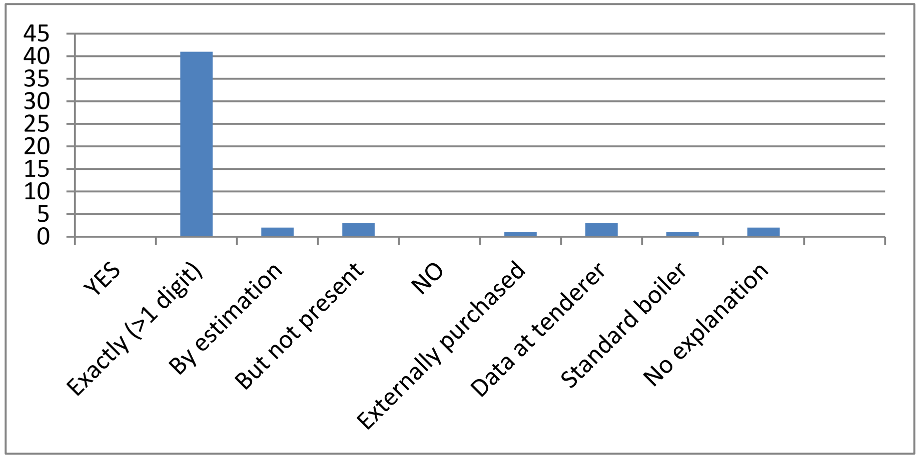




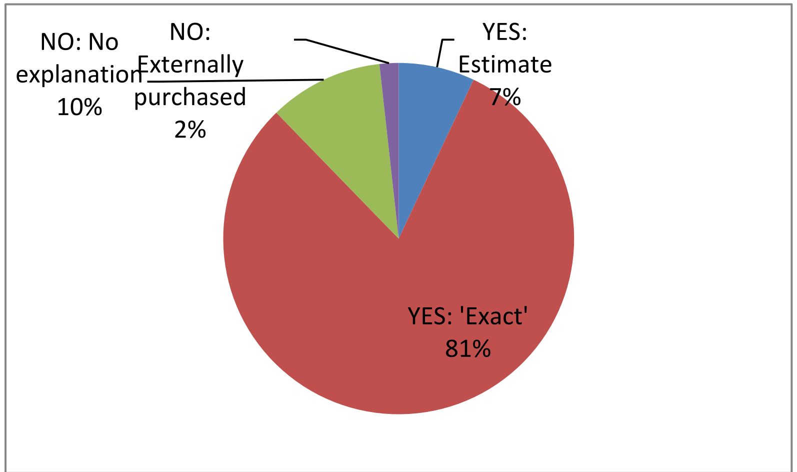
Steam use an operation

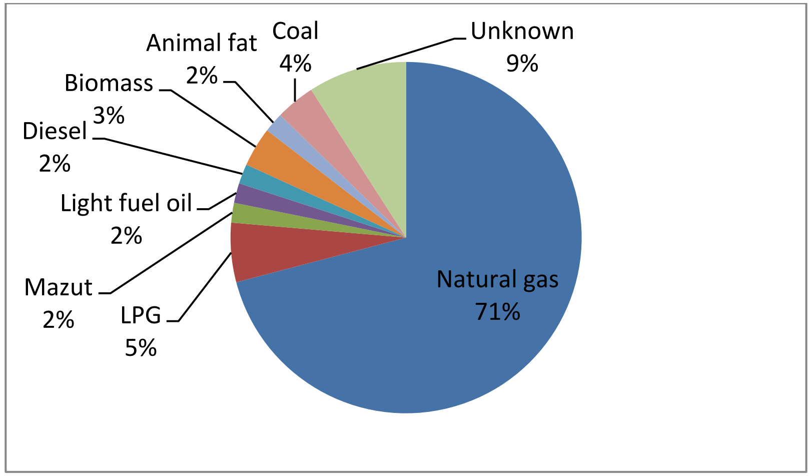
1. Do you know the efficiency of your steam boiler?



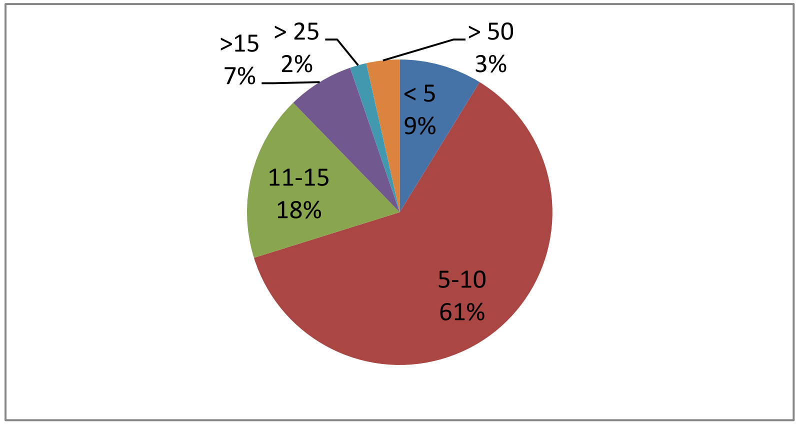


2. How much fuel is used for steam production and what type (gas, oil, biomass, other)?

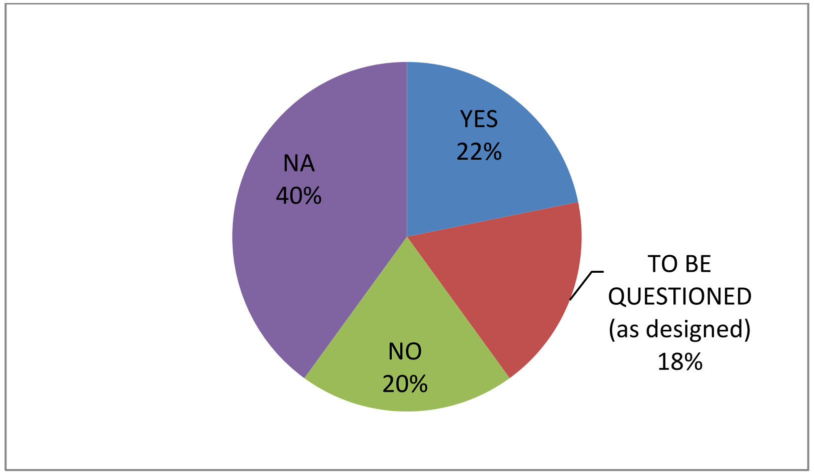


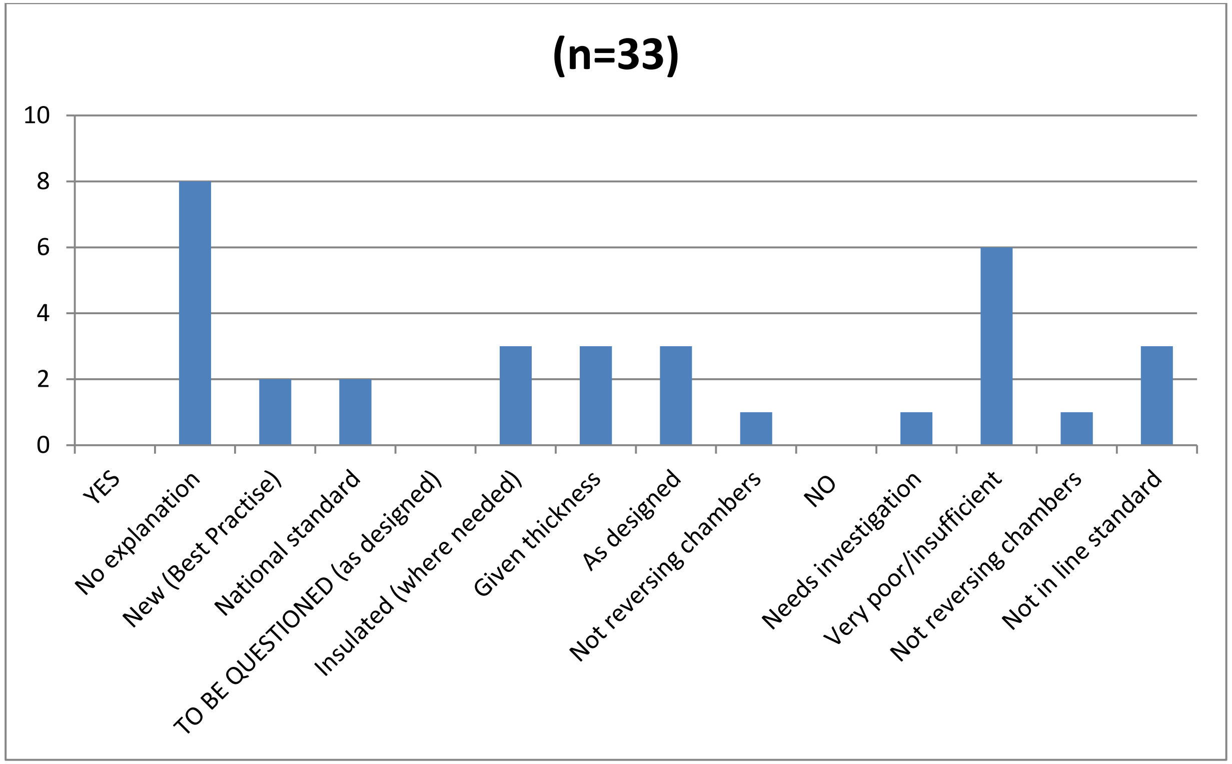


3. What is the operation pressure of the steam boiler and how does it relate to the required steam pressure (or temperature) in the process?



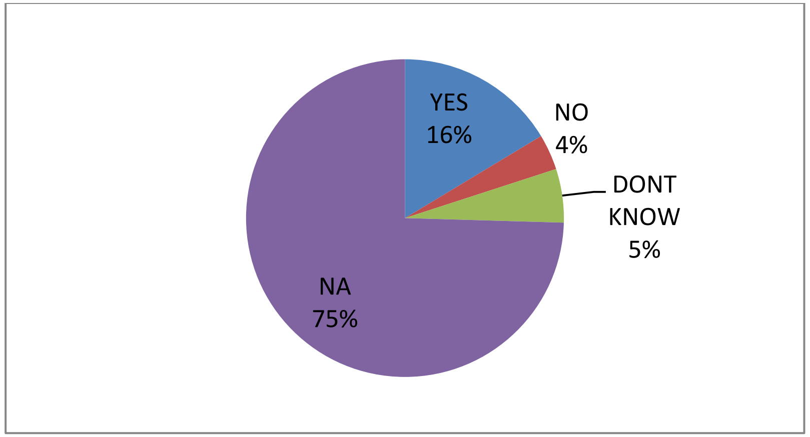
4. Does your steam boiler have a good insulation in its envelope?



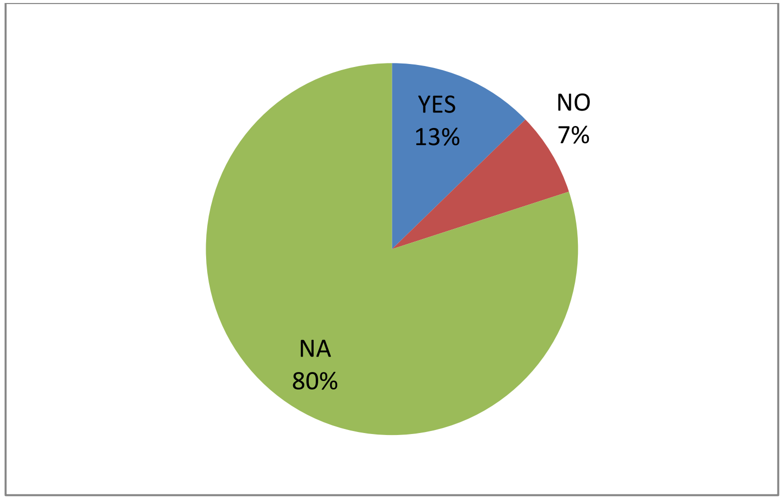

(n=33)
10
8
6
4
2
0
YES
No explanation
New (Best Practise)
National standard
TO BE QUESTIONED (as designed)
Insulated (where needed)
Given thickness
As designed
Not reversing chambers
NO
Needs investigation
Very poor/insufficient
Not reversing chambers
Not in line standard

STEAM UP

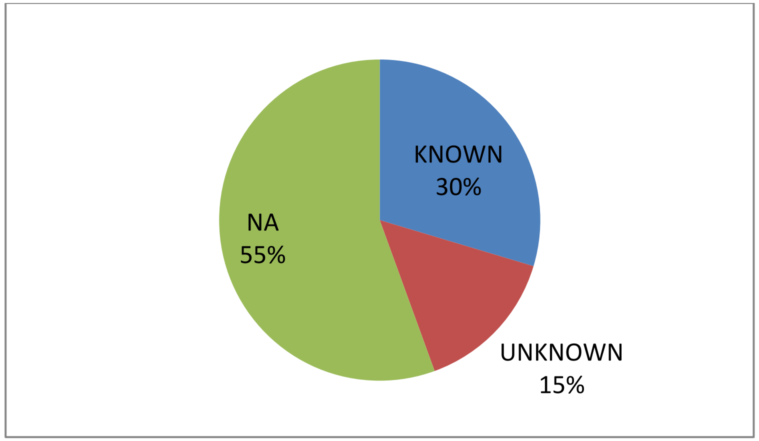
a. Is there a national standard for steam boiler insulation and is that followed?

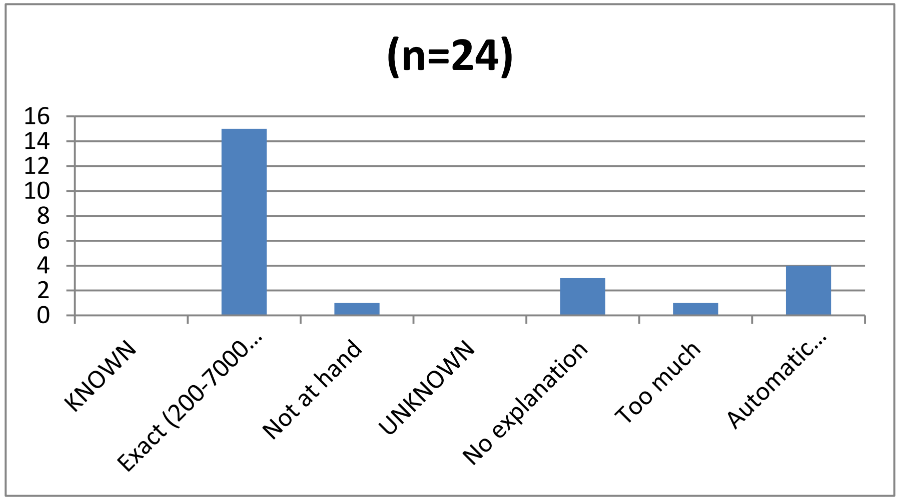


b. If no standard, do you know what the insulation thickness is?

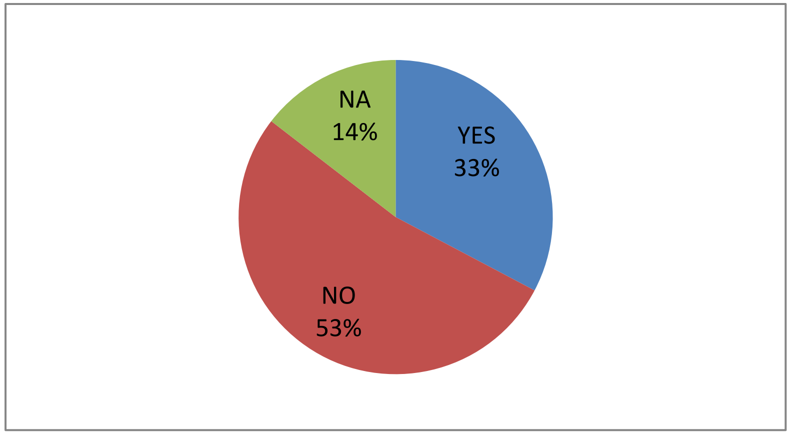


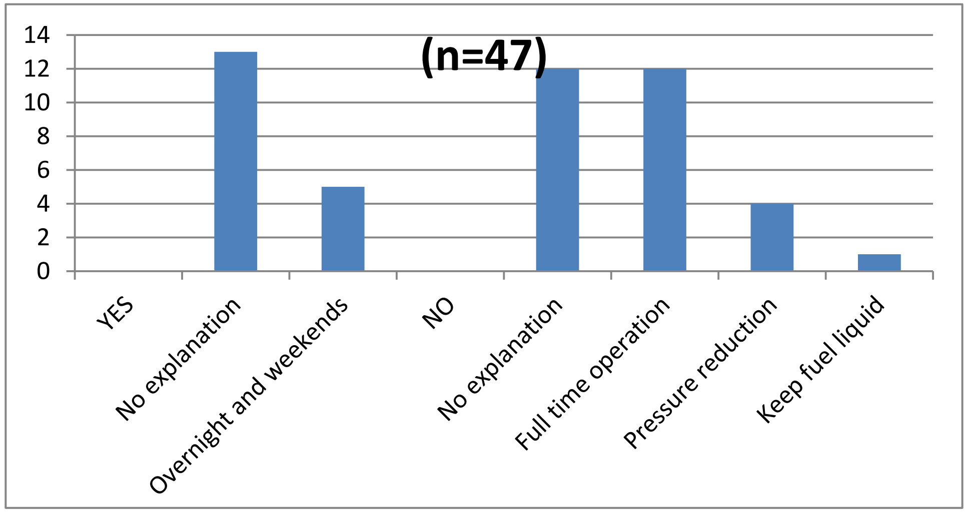
5. What are the conductivity settings for your boiler water? Why at that specific level?



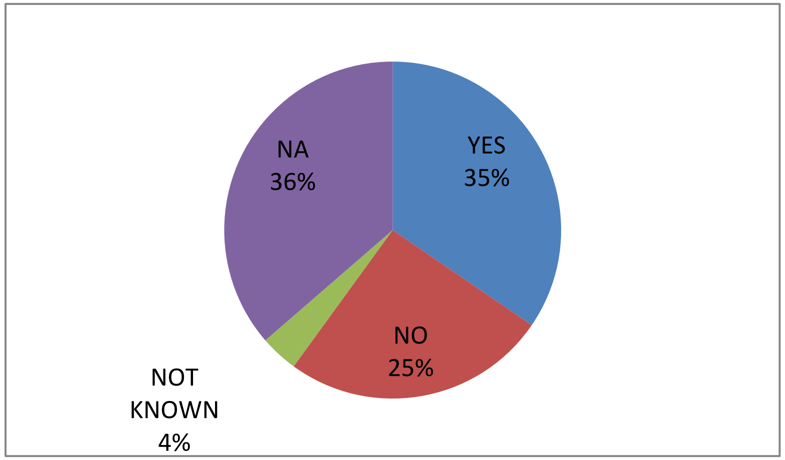


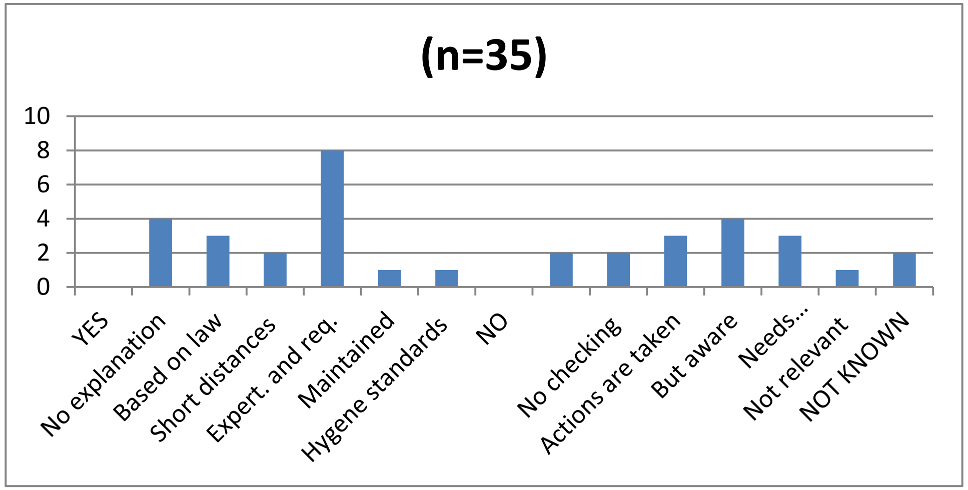
6. Is the installation turned off when there is no steam demand (during stand still, overnight and/or in the weekend)?



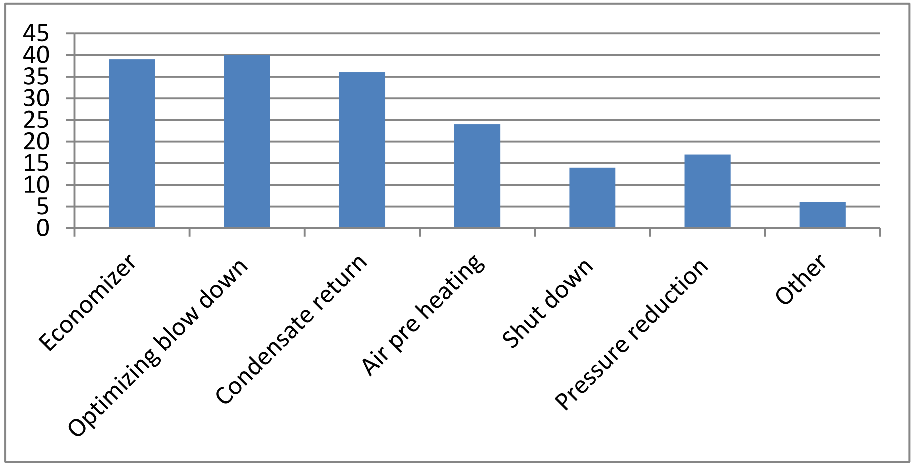


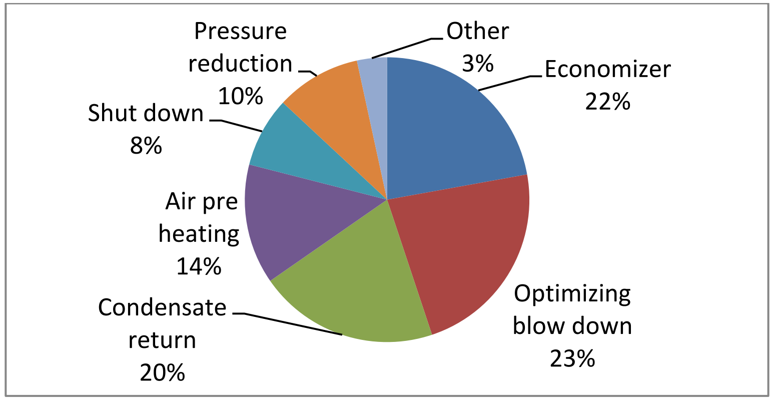
7. Does the distribution system meet the optimum criteria and what is the basis for this criteria (standard, guidelines,…)?



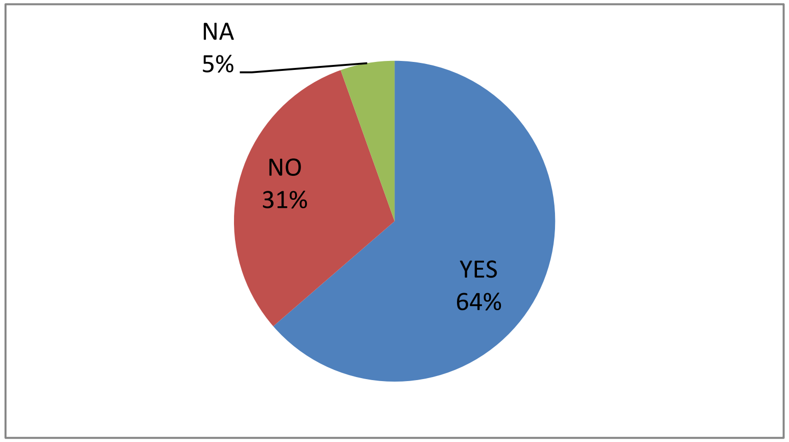


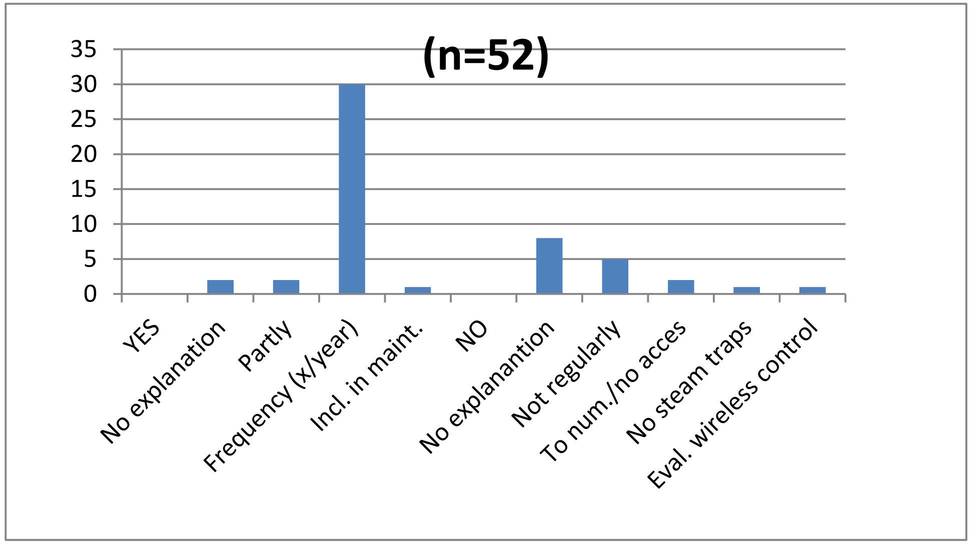
8. What kind of energy saving measures are already taken to improve steam efficiency and are there any other measures you can think of?





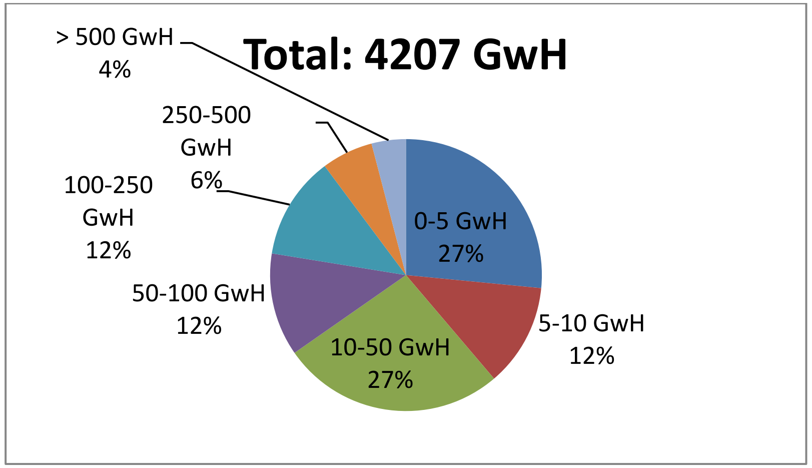
9. Are steam traps regularly checked?



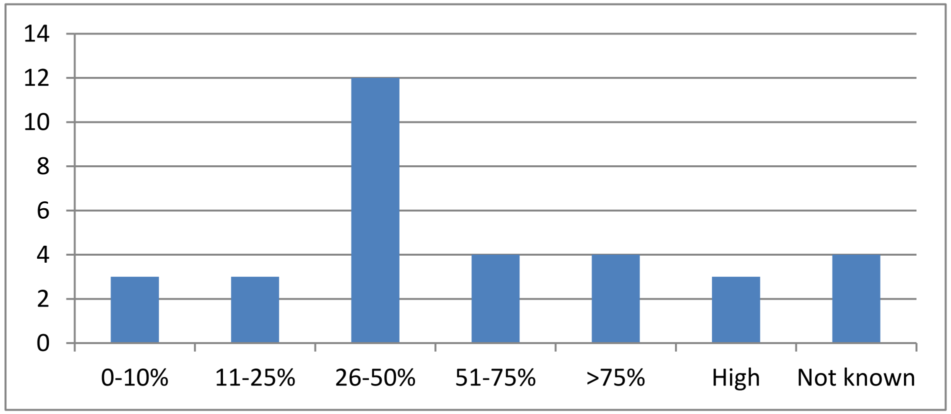


Energy use, energy costs and potentials for savings

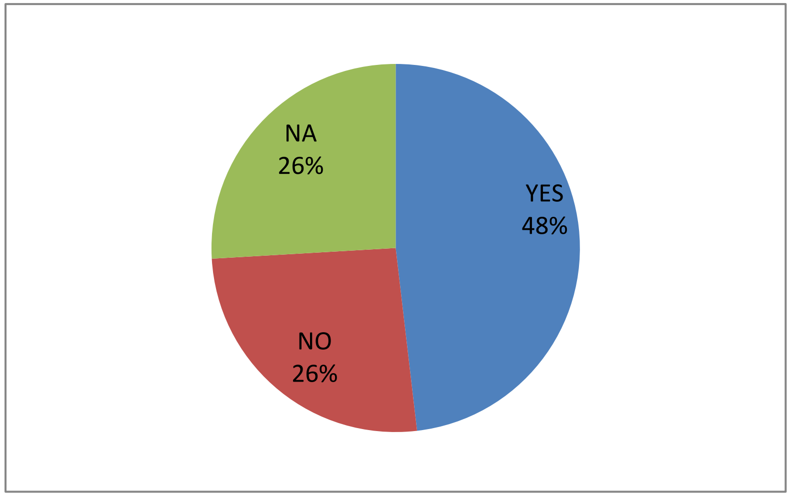
1. What is the total energy use for steam production in your enterprise?

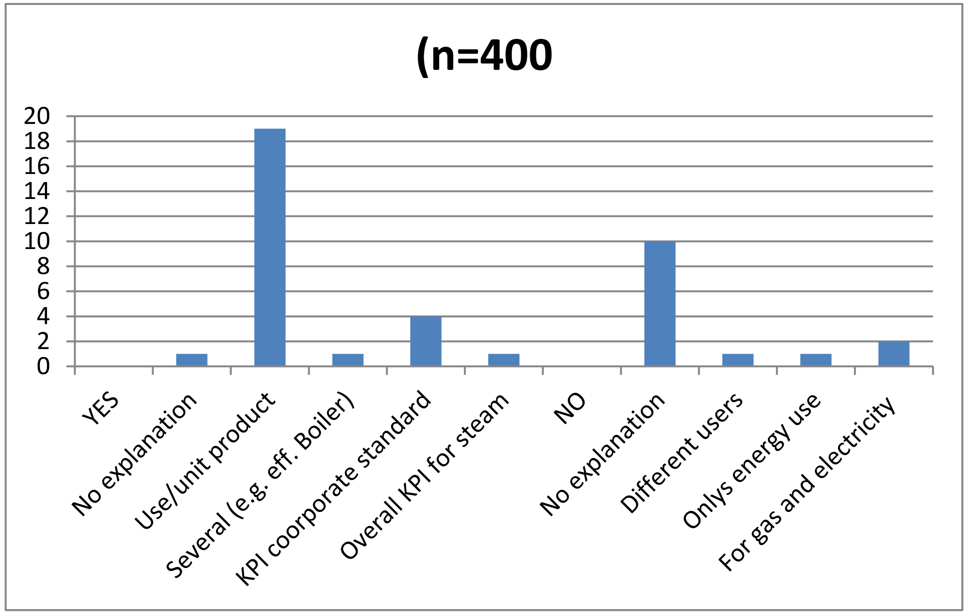


2. How does this relate to the overall energy use for production in your enterprises?

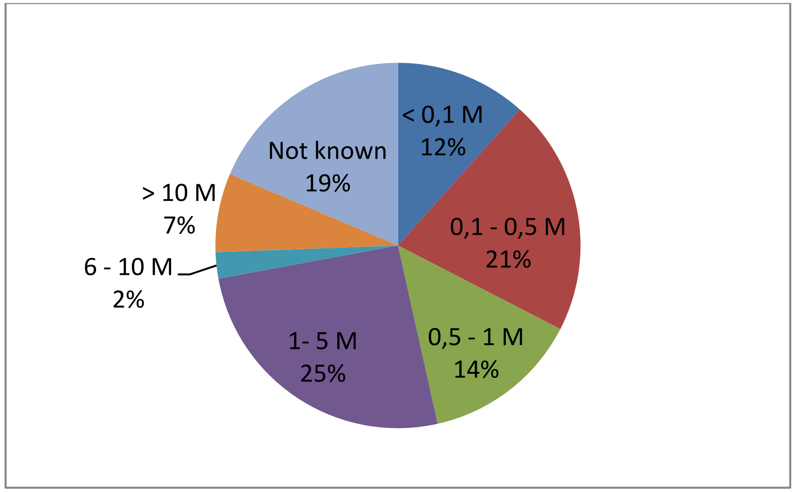


3. Are there EPI's for steam defined?

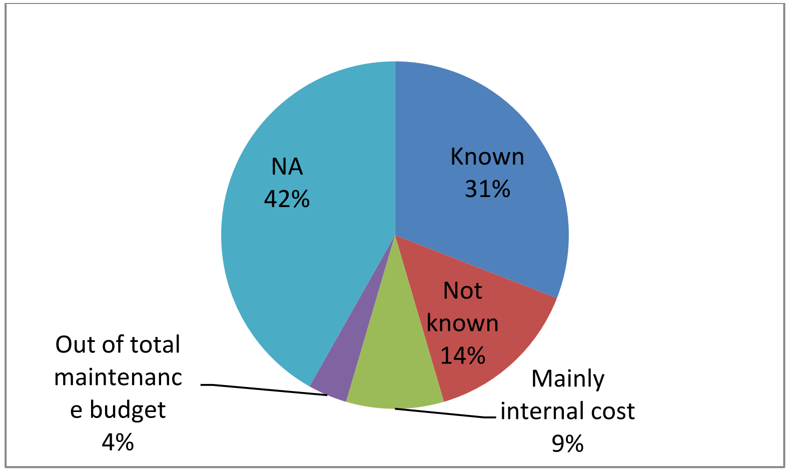




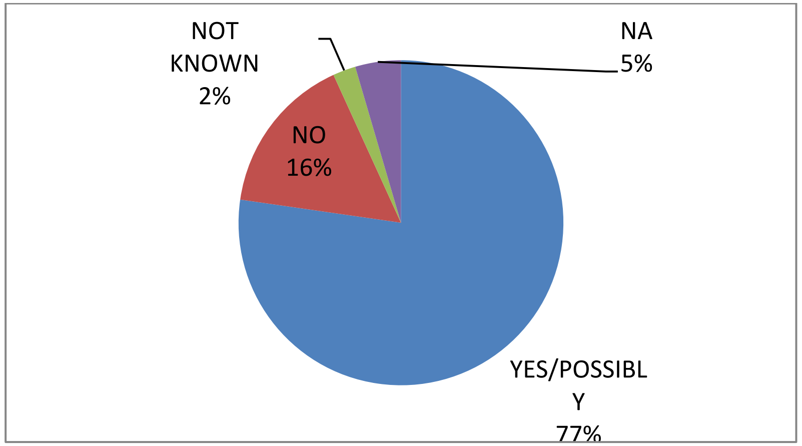
4. What are the total costs for steam production annually?



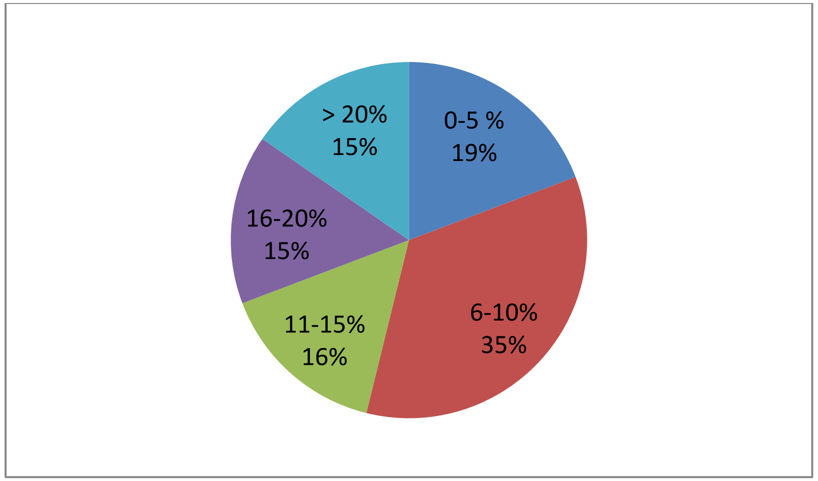
5. What are the total costs for inspection, maintenance and operation annually?



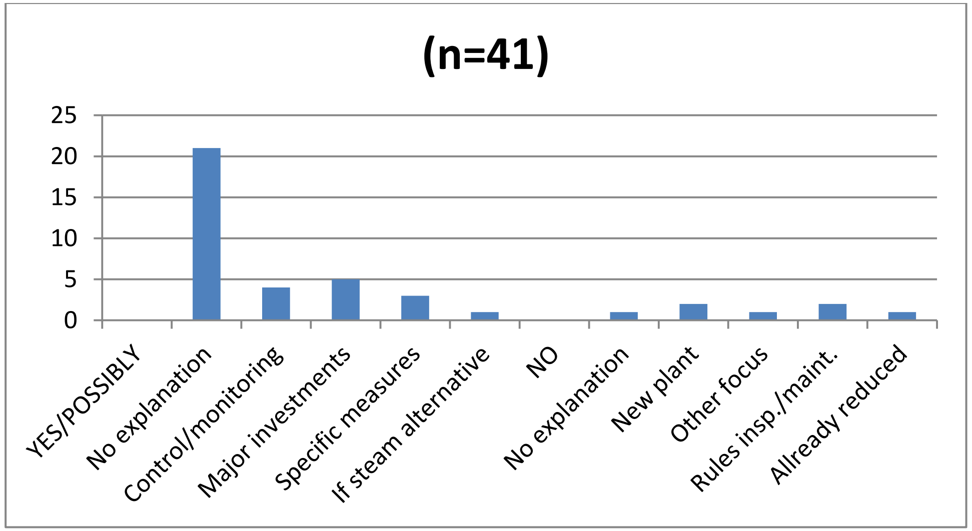
6. Do you think this operation costs can be decreased?



a. If yes, can you estimate how many savings (%) can be made?



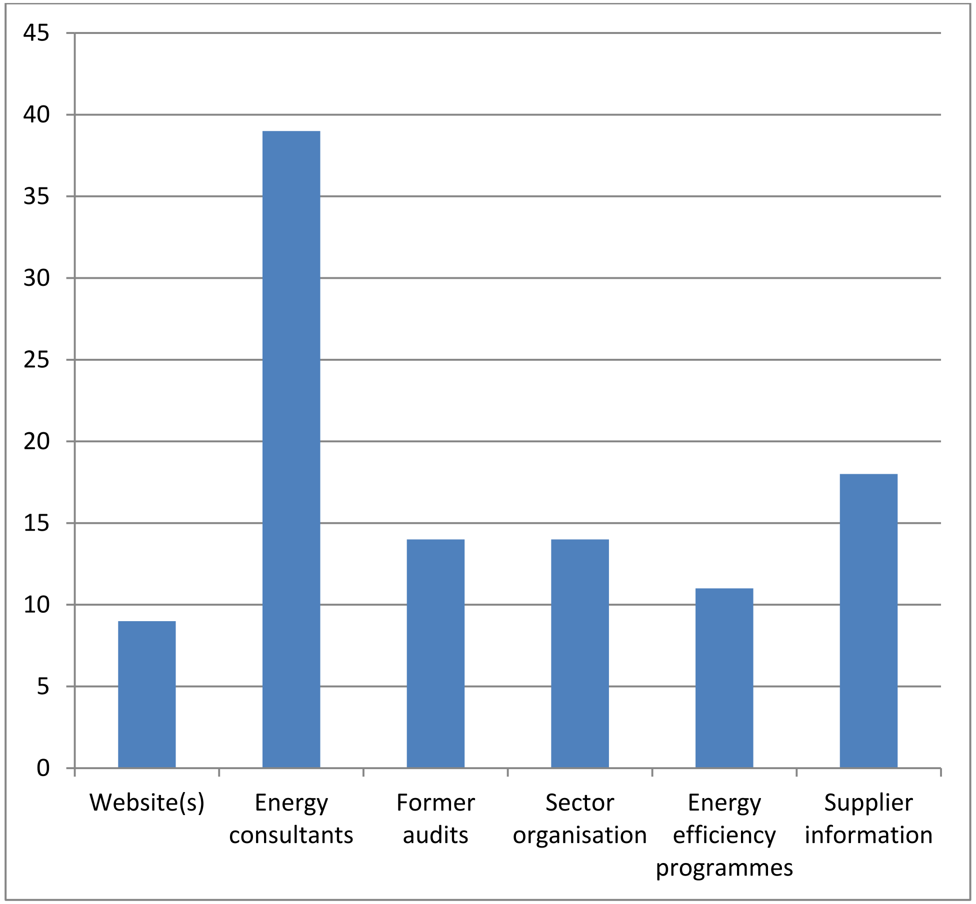
b. If no, why not?



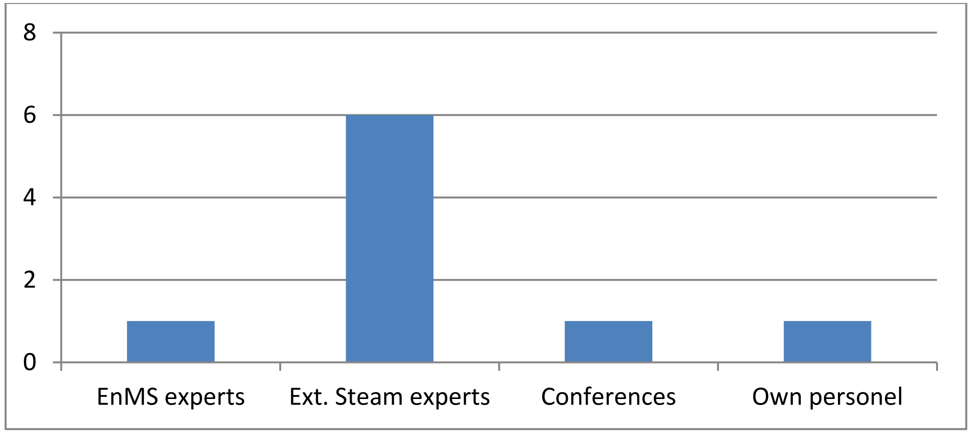
STEAM UP

7. Do you have information on energy savings options for your steam system?

a. If yes, what is your source?



b. If no, who would you turn to get this information?

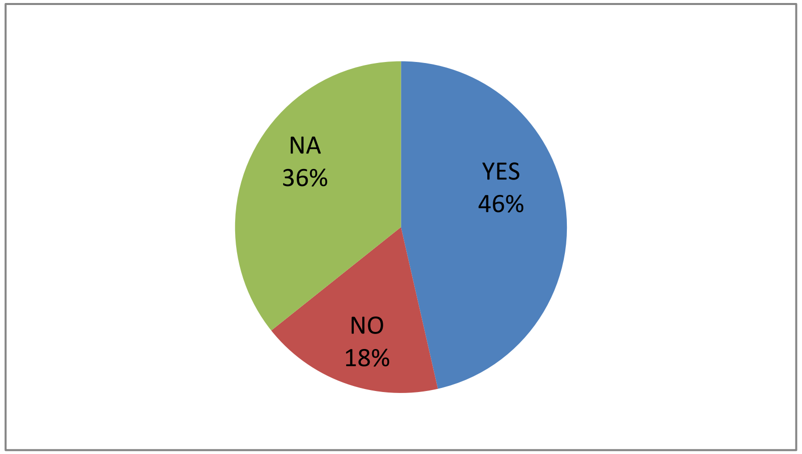


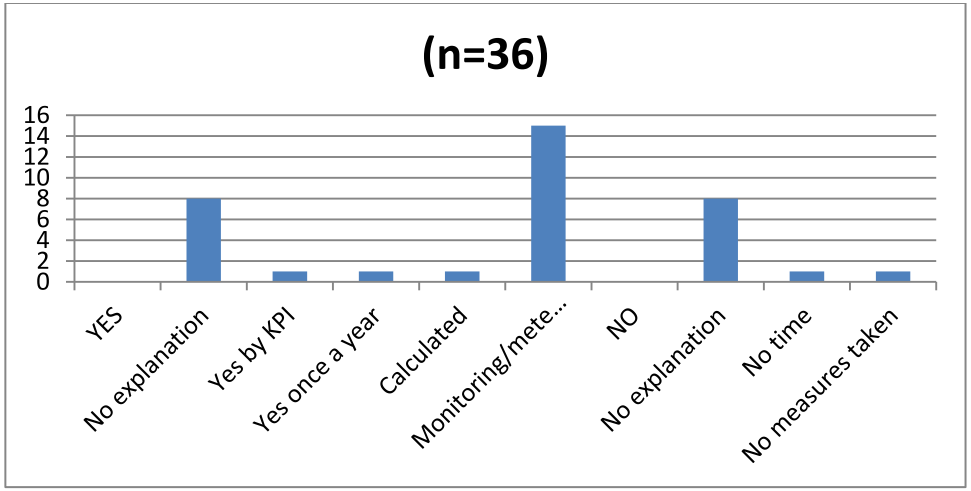
8. Are there already any energy saving measures taken:

b. If yes, what kind of measures are already taken?

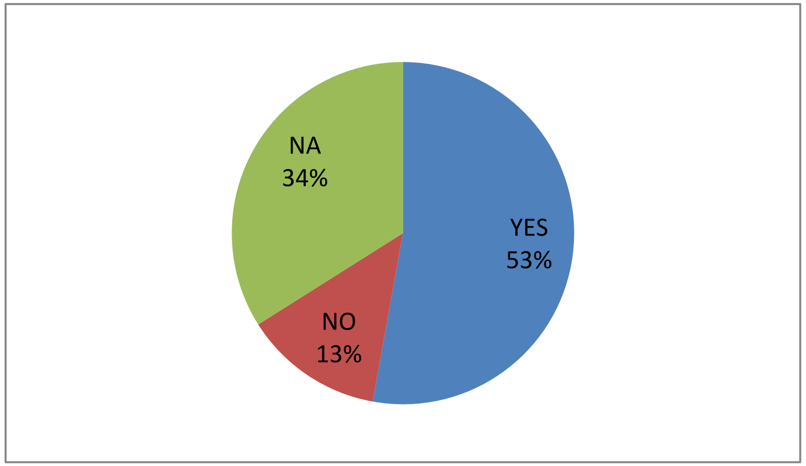
a. If no, why not (What is hindering this?)

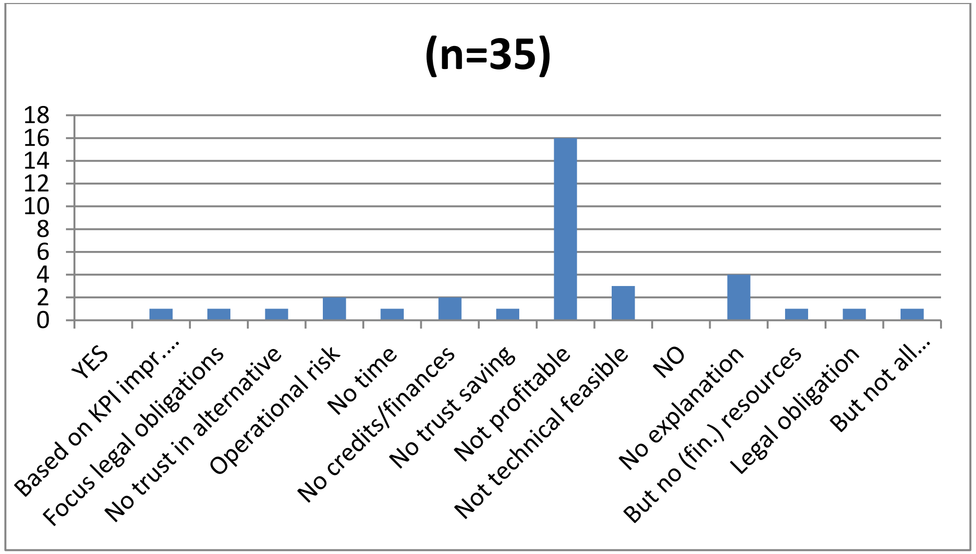
9. Is the energy saving of this measure verified (on a regular basis)?



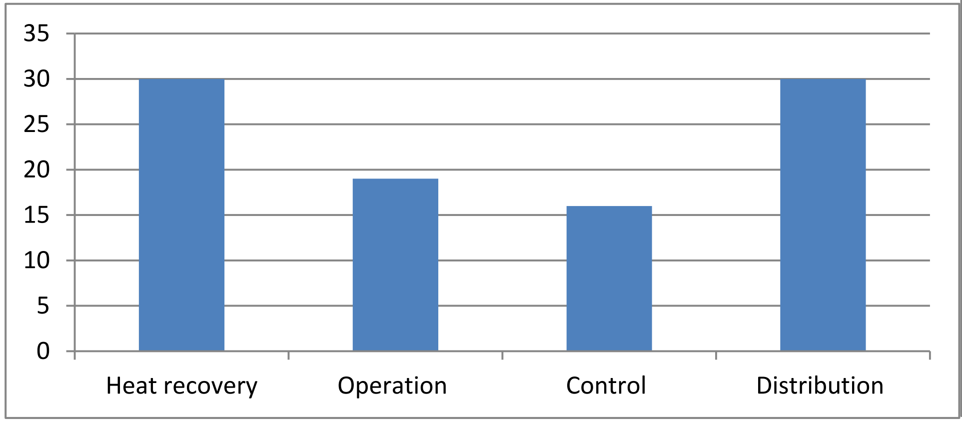


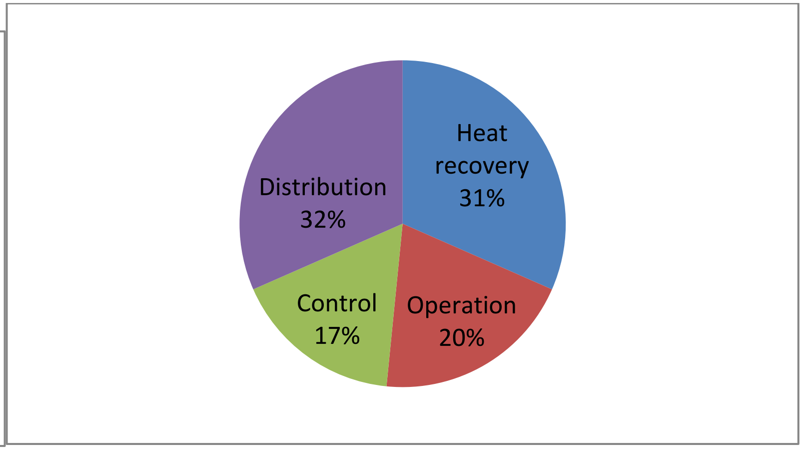
10. Are there any energy saving measures analysed and rejected by your organisation?



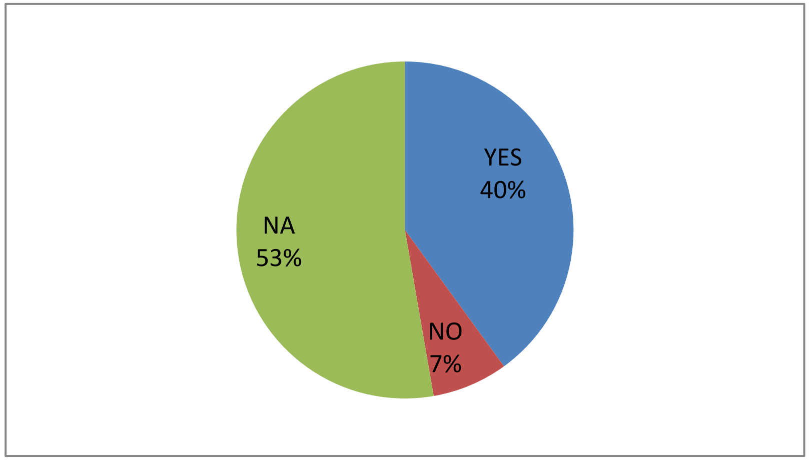


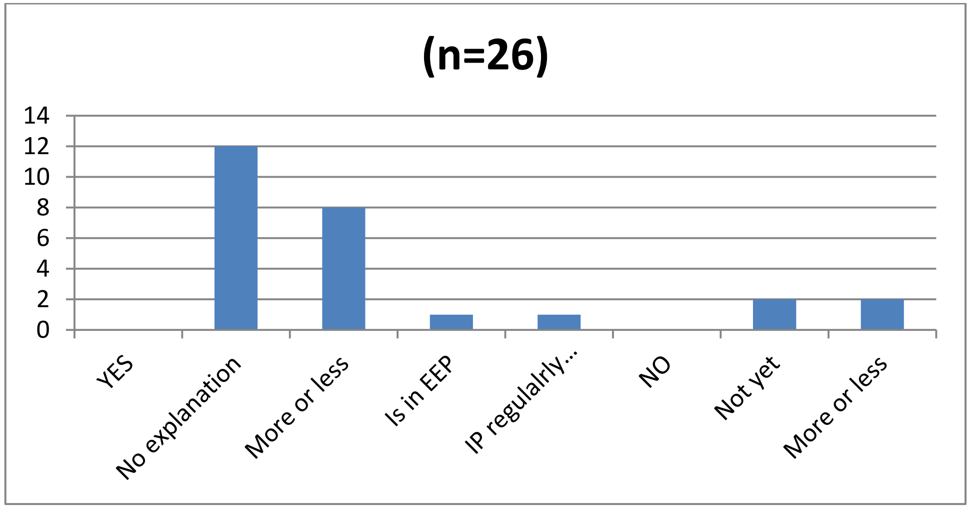
11. What saving measures (still) can be taken in your organization?



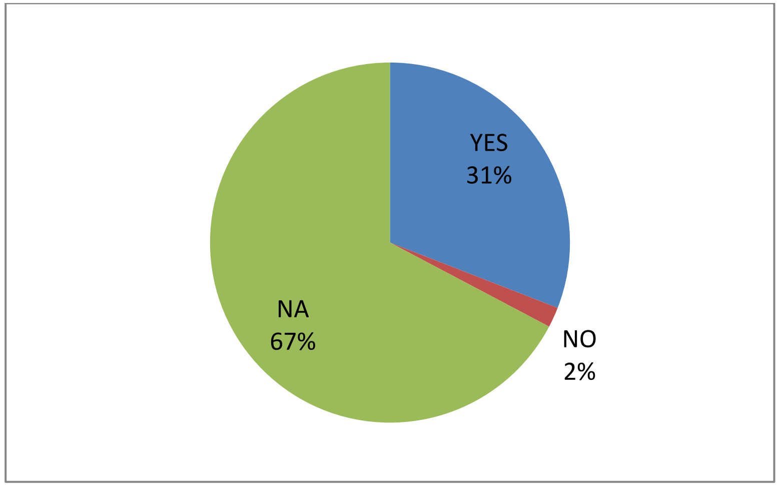


12. Do you know how many energy/money can be saved by taken this measure?

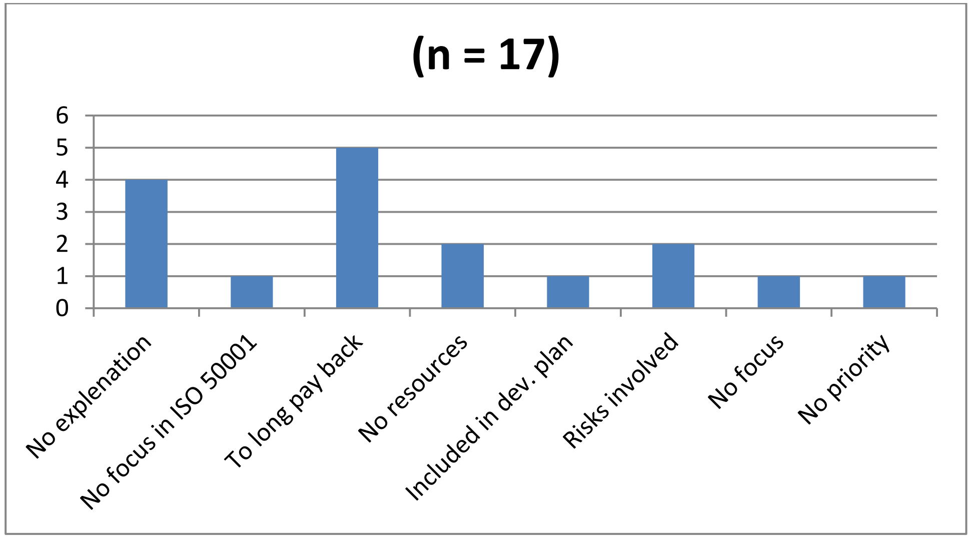




13. If yes, does your management know how many energy/money can be saved by taking this measure?



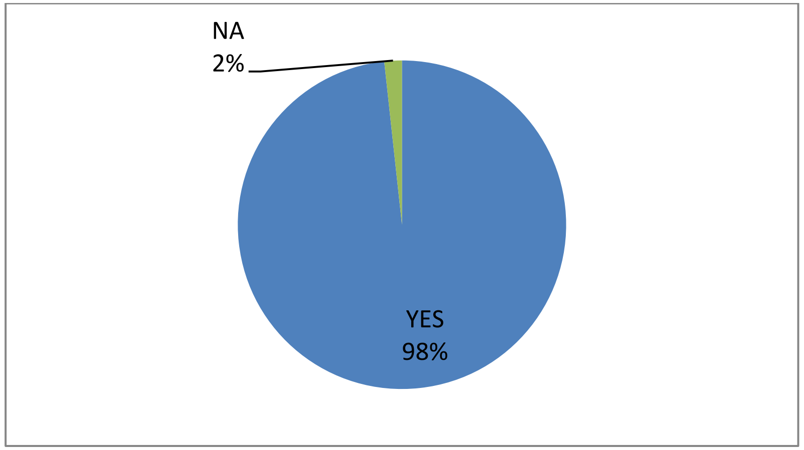
a. If yes (and considering that the measure is economical viable), why is the measure still not taken?

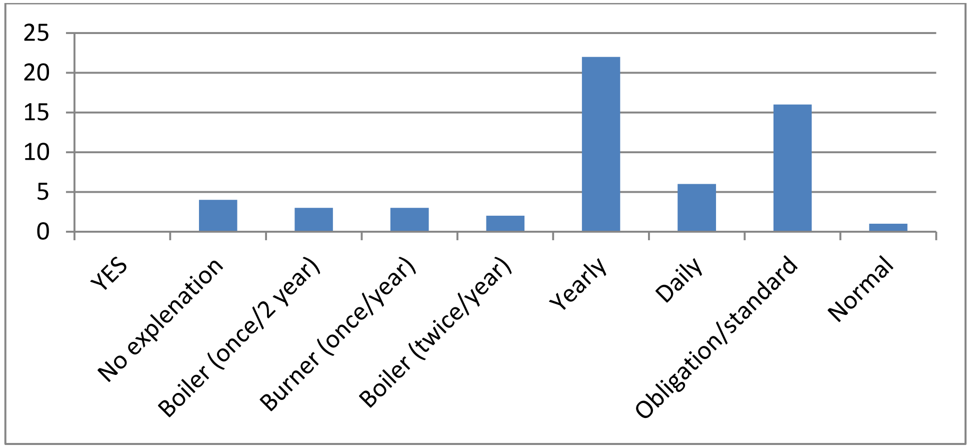


b. If no, why not? Head technical services is no part of management team

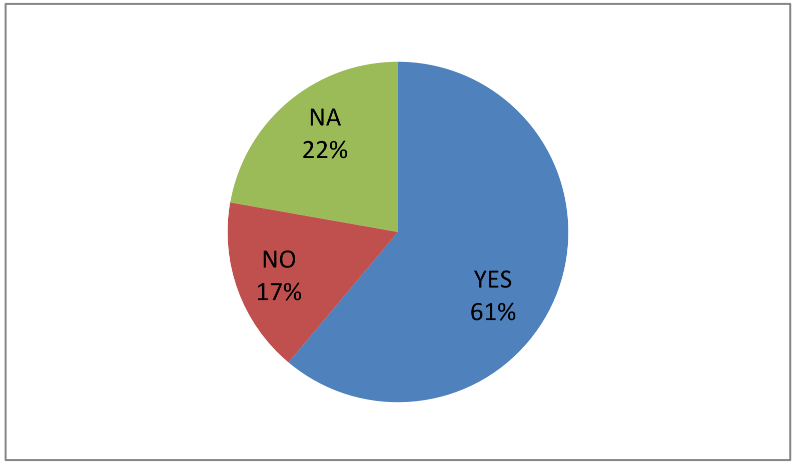
Check and audits

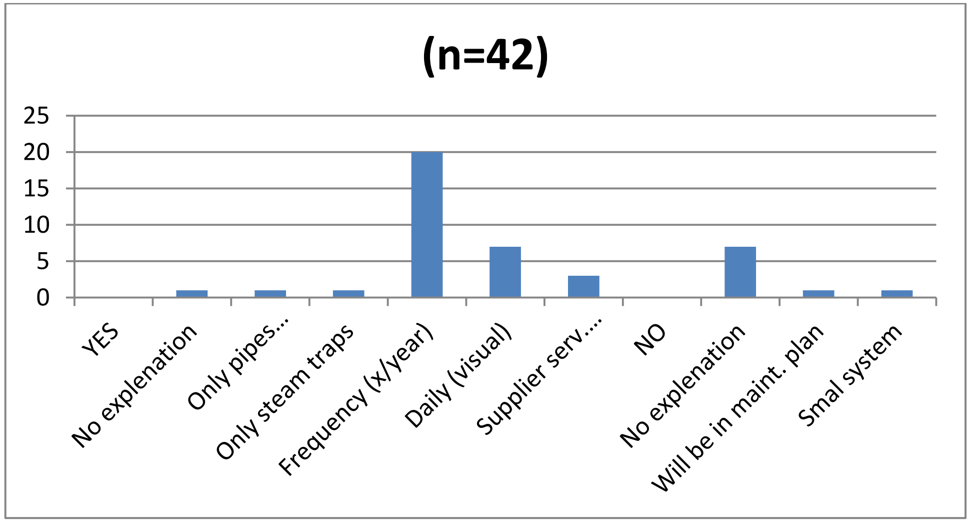
1. Is/are the steam boiler(s) checked on a regular basis and if yes on what frequencies?



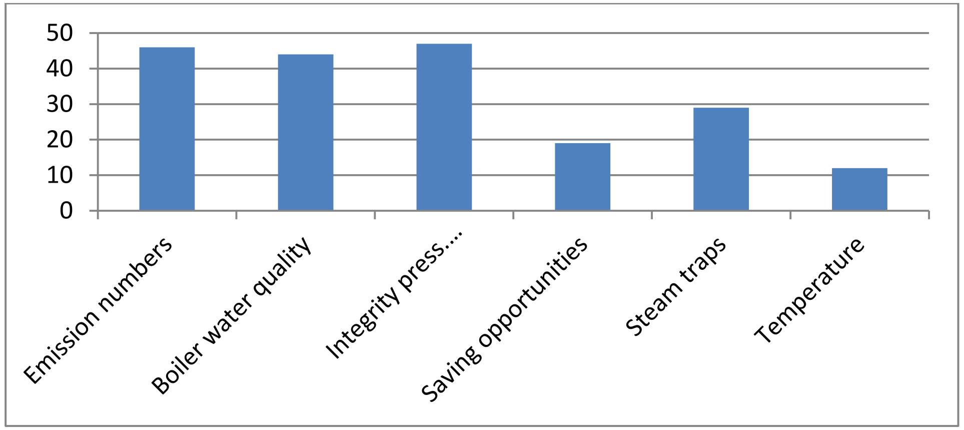


2. Is the distribution system checked on a regular basis and if yes on what frequencies?

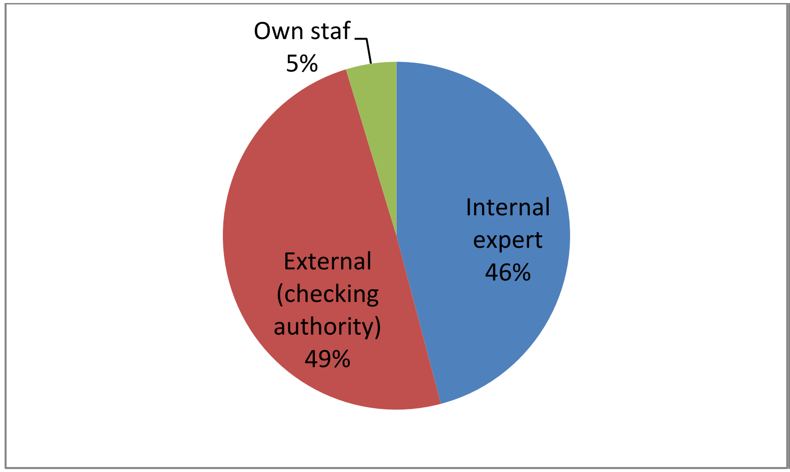


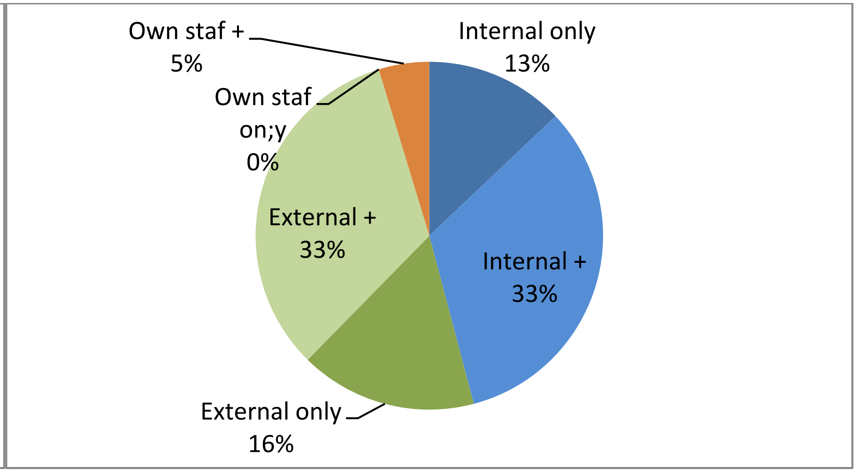


3. If a regular check is being performed what is being checked on?



4. Who is doing the steam system checks

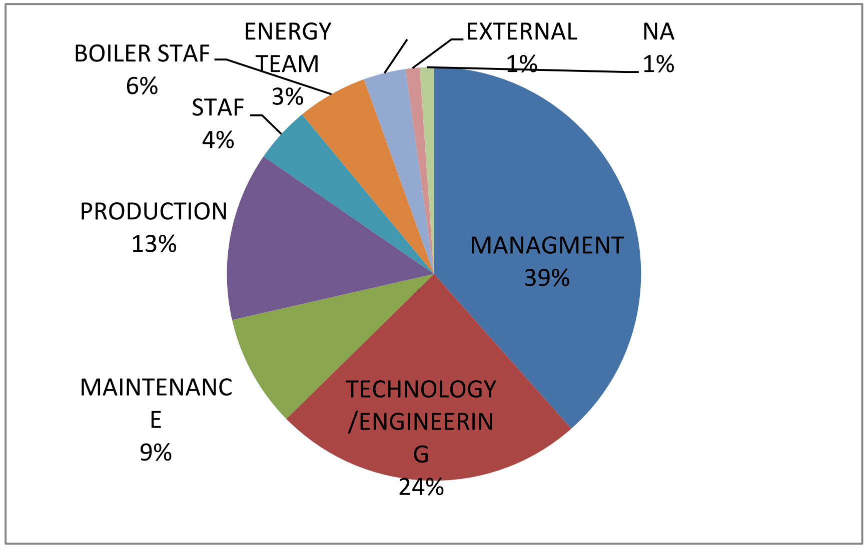


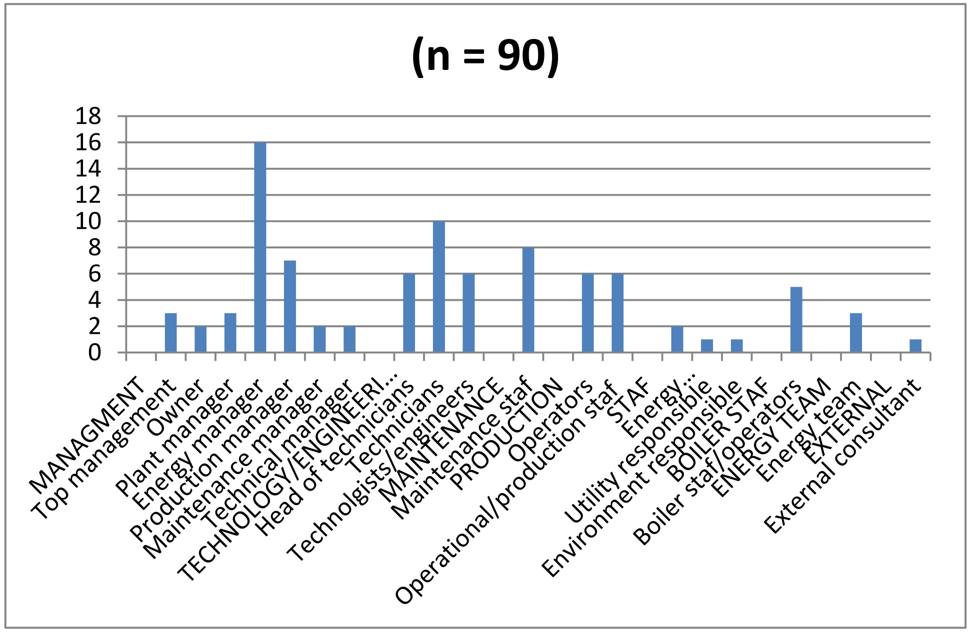


STEAM UP

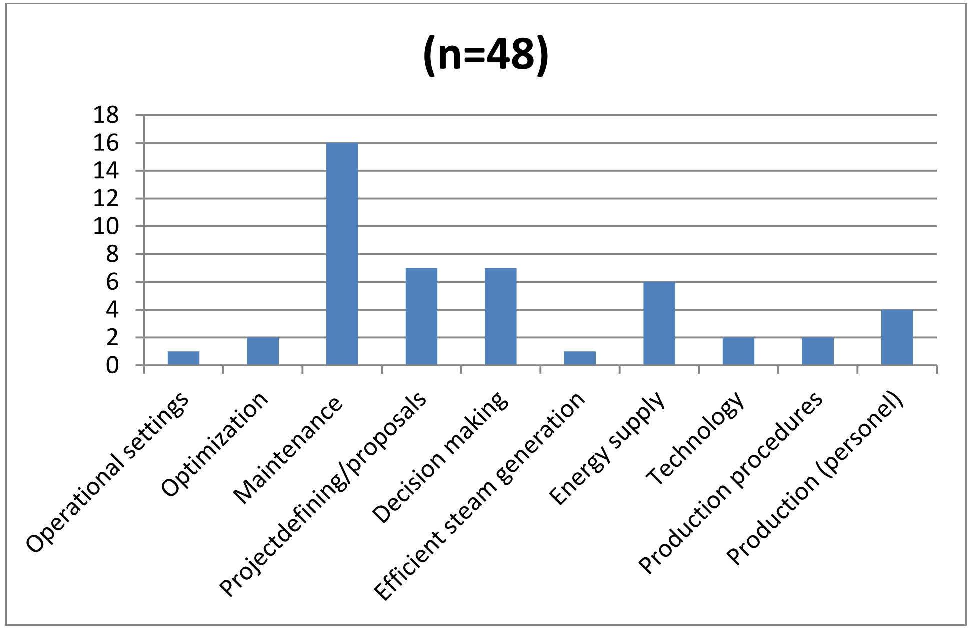
Key players in in your organisation for steam and energy efficiency

1. Which people in your organization have an (direct or indirect) influence on energy use and energy efficiency?

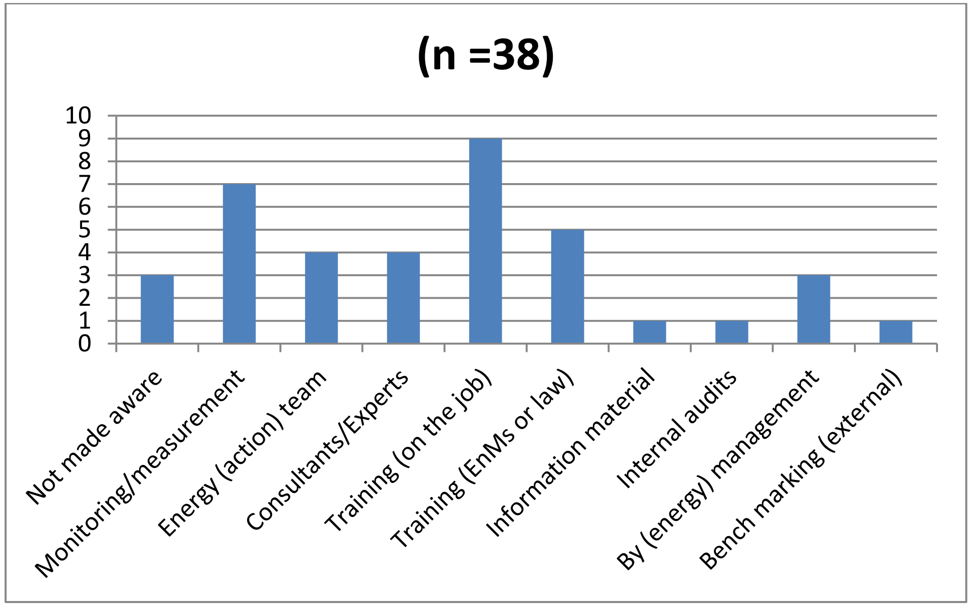




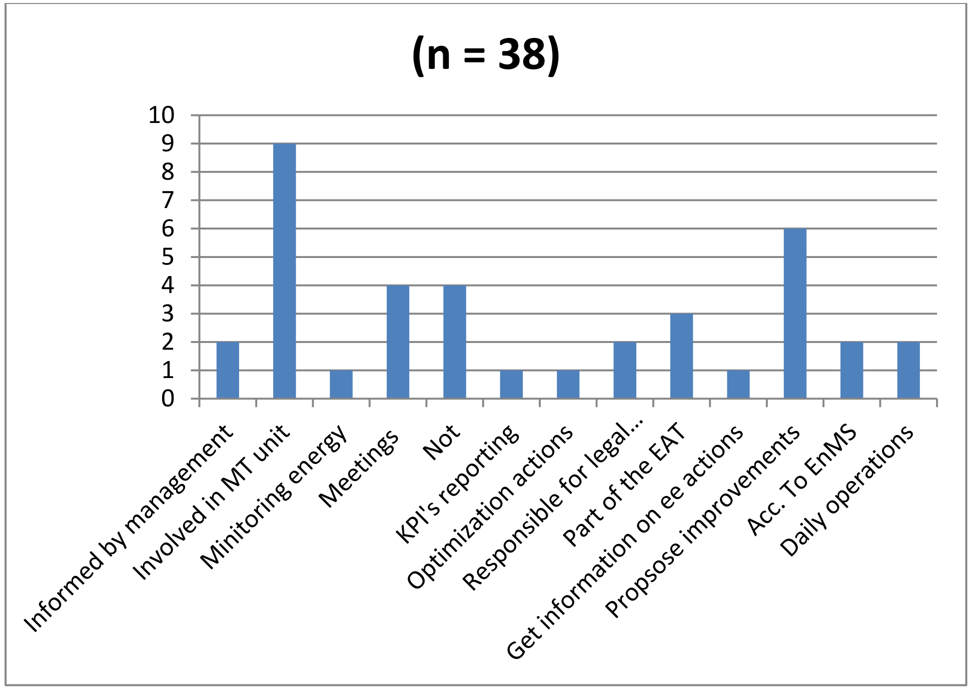
a. What kind of influence do these people have?



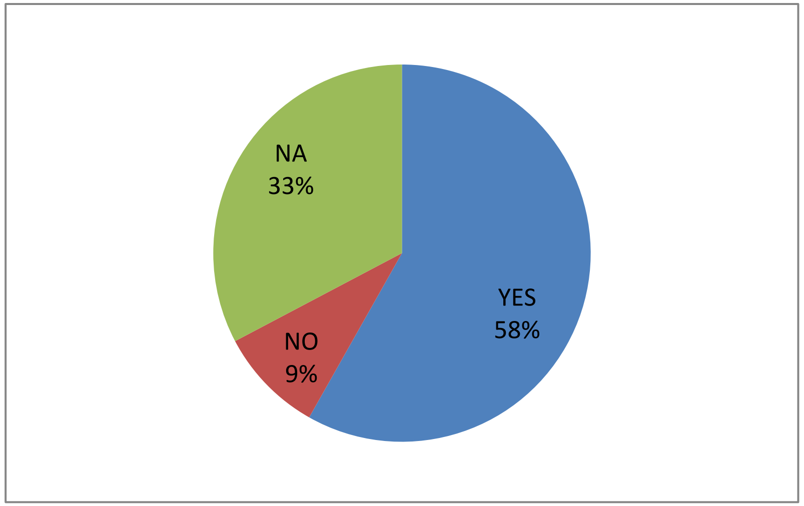
b. How are the people made aware of this influence (training,...)?

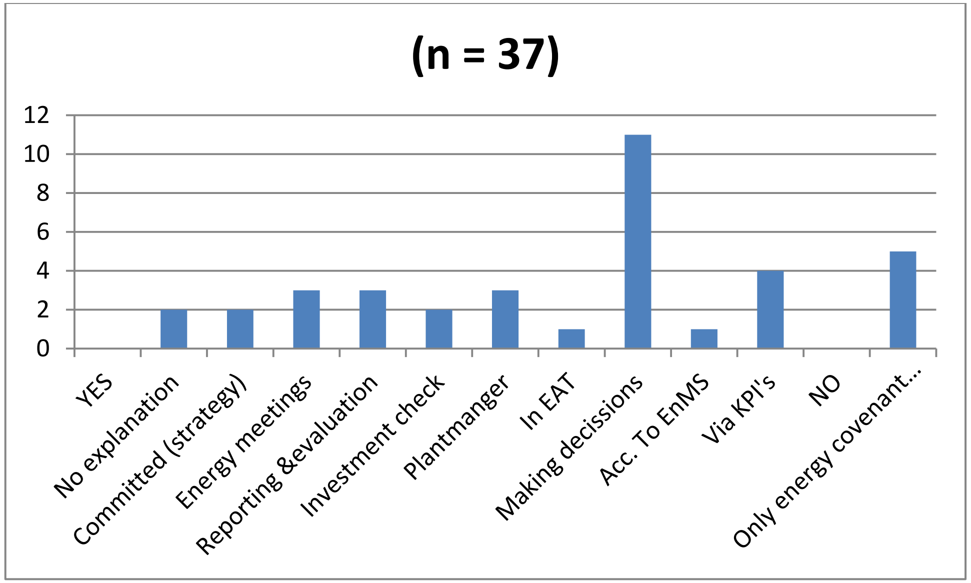


2. How are they involved in improving energy efficiency in your organization?



a. Is top management involved? i. If yes, how? ii. If not, explain why?

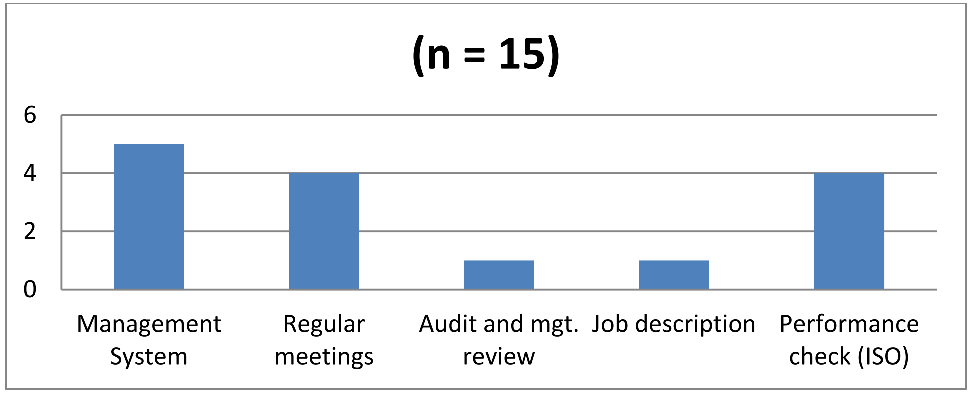




3. What are their roles, tasks, responsibilities and authorities in relation to energy and energy efficiency?

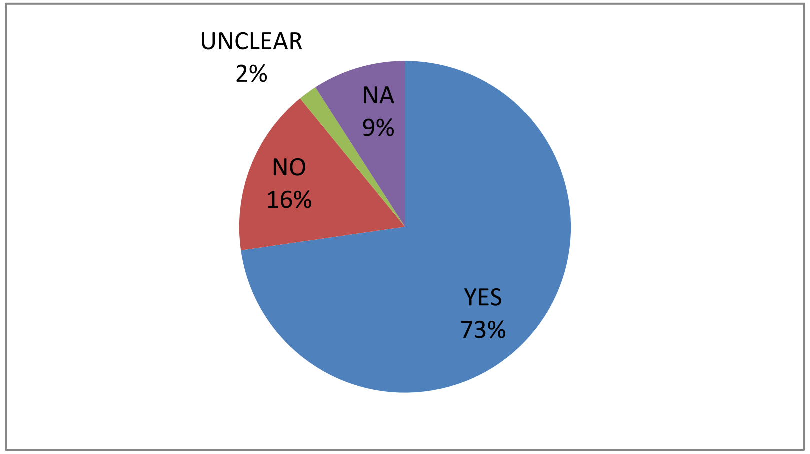
To less answers and to divers to give a visual representation

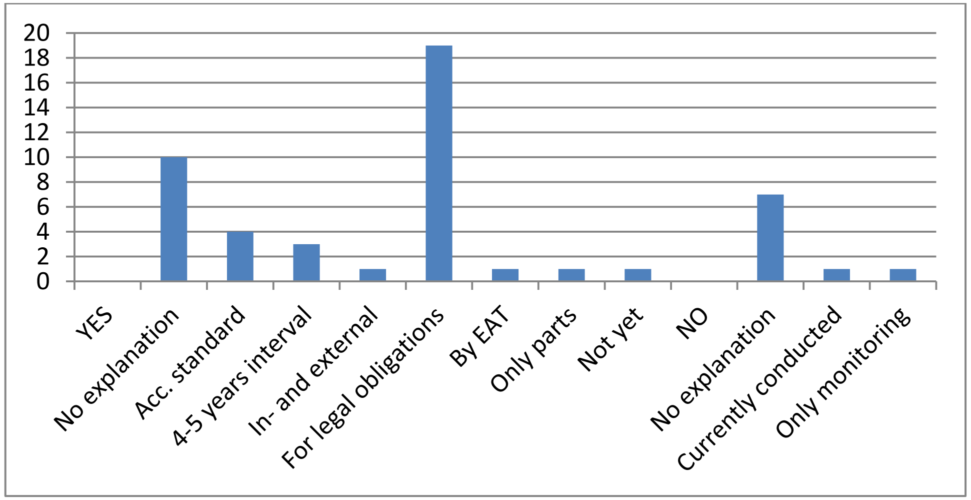
4. How is the fulfilment of these roles, tasks and responsibilities checked on a regularly basis?



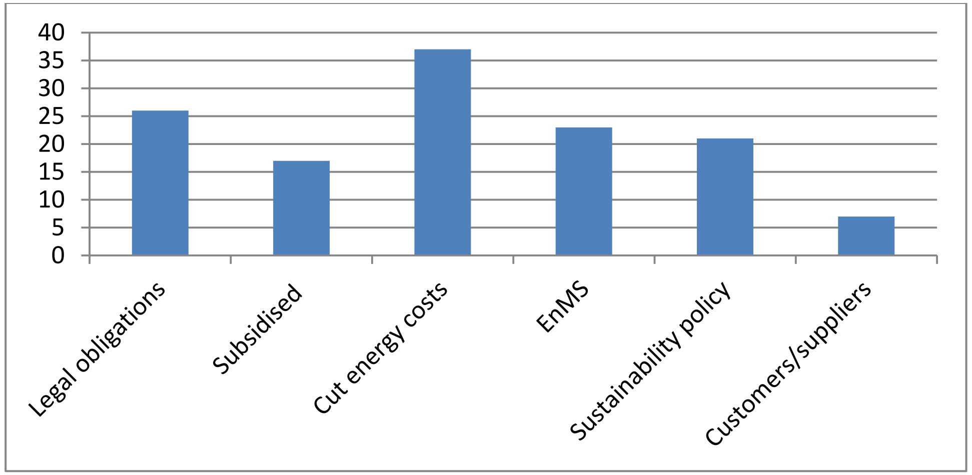
Energy Auditing Practises

1. Are energy audits regularly executed at your enterprise?

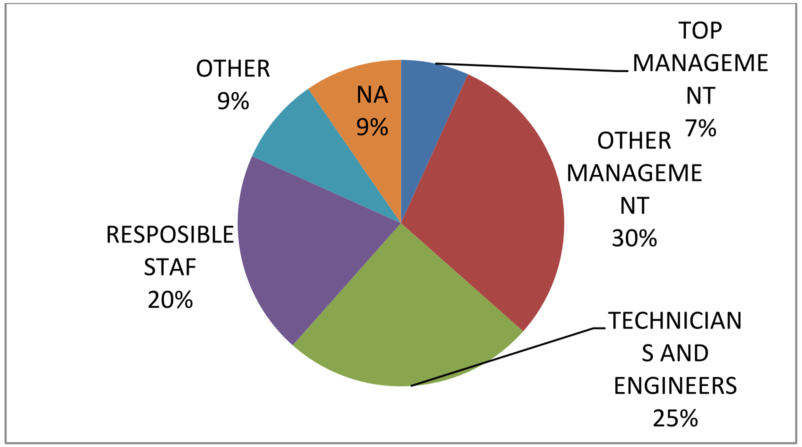




2. What are the main reasons for your enterprise to do an energy audit?

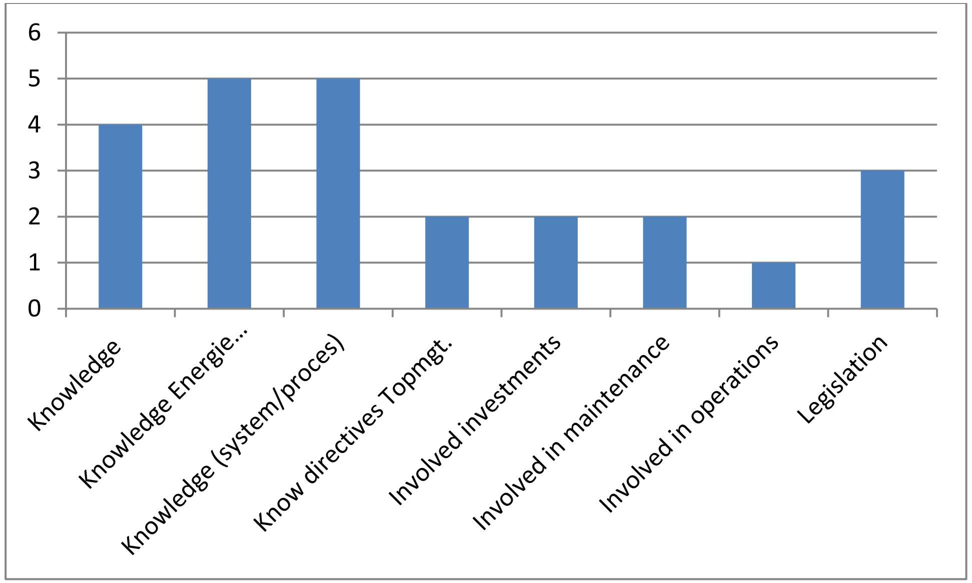


3. Which people in your organization are involved in the auditing process and which relevant education do they have?

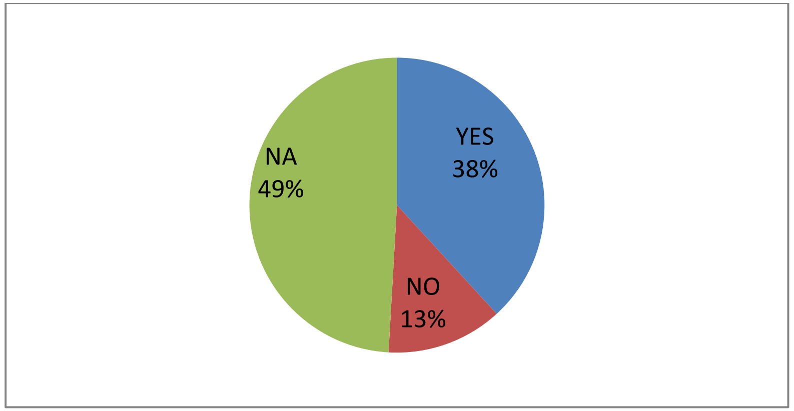


STEAM UP

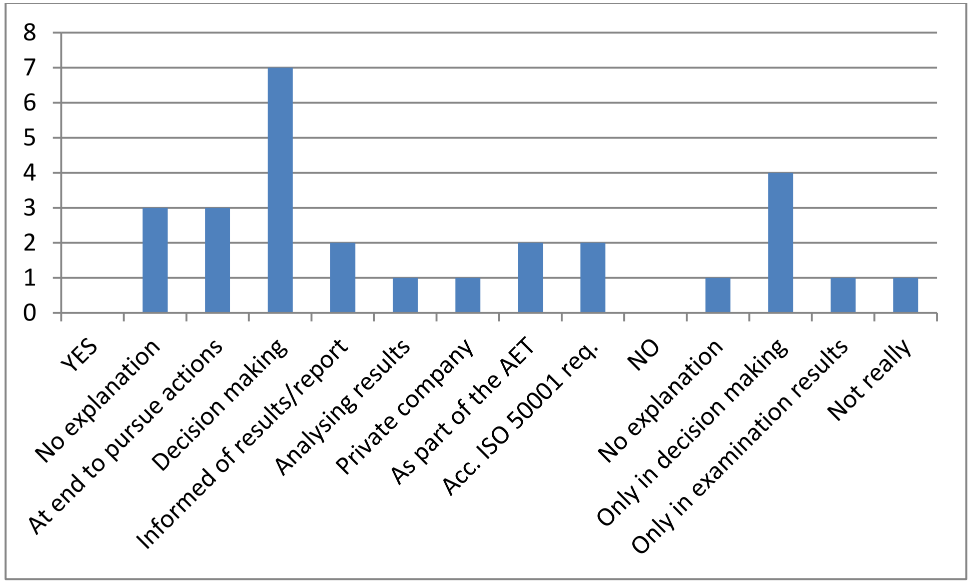
4. Why specifically those people?



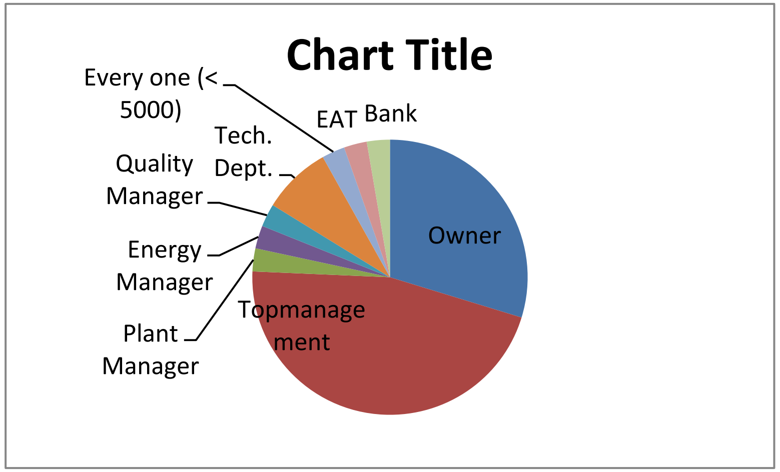
5. Is (top) management involved?



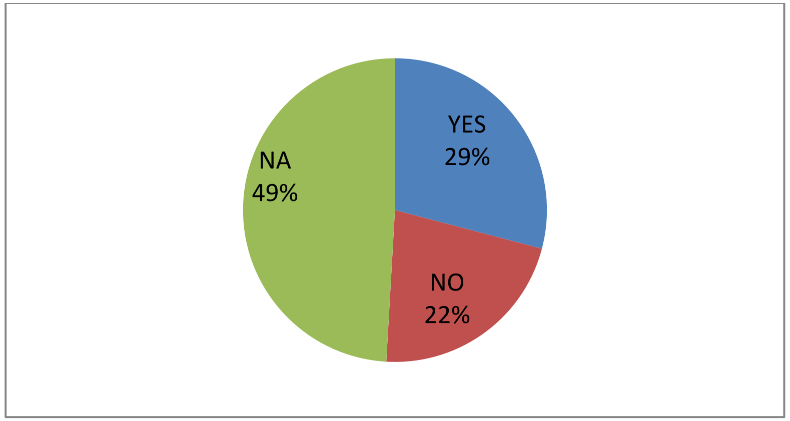
a. If yes, how? b. If not, explain why?



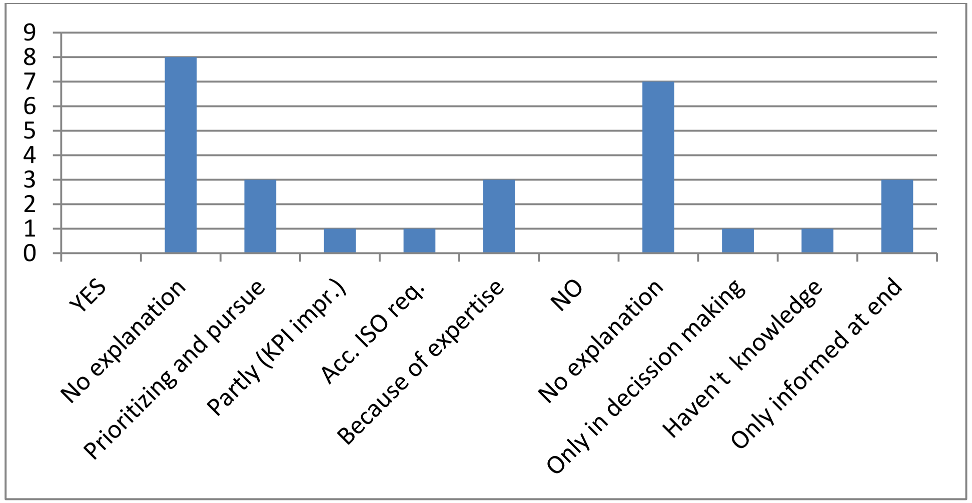
6. Which people have an influence (or are making decisions) on the implementation of energy saving measures?



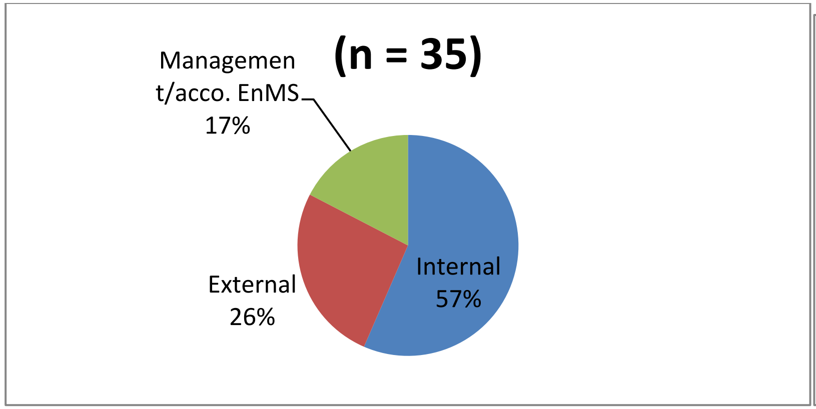
7. Are they involved in (part) of the auditing process?

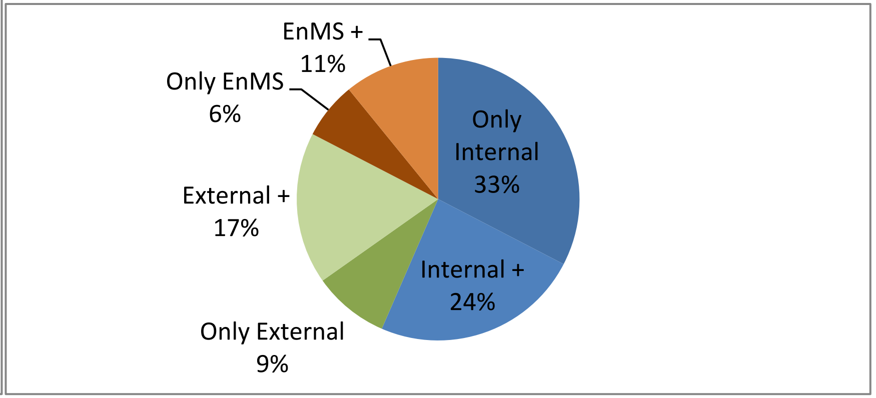


a. If yes, how? b. If not, explain why?

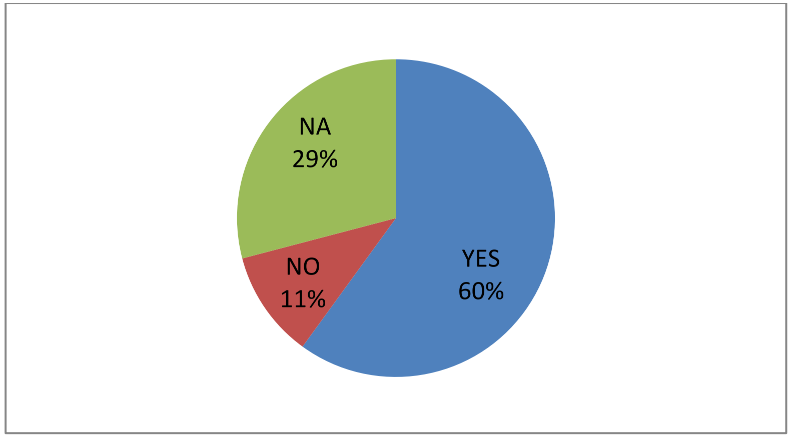


8. How are audit results being followed up in your organisation (implementation guiding, monitoring) by:

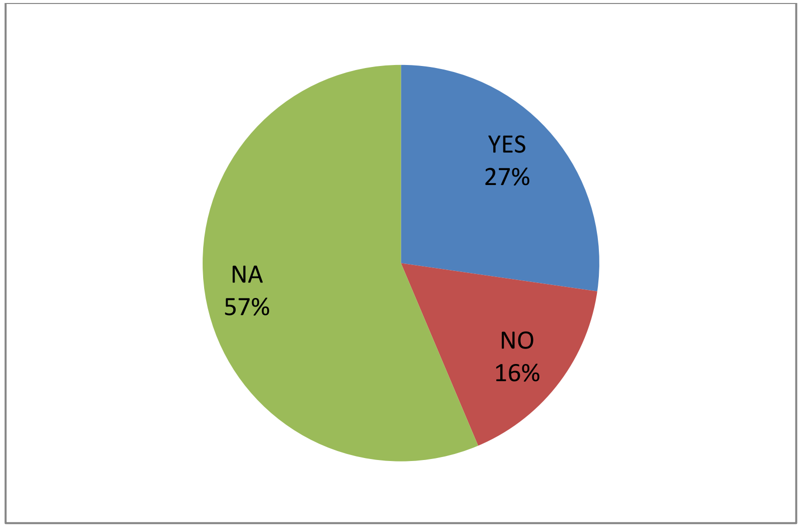




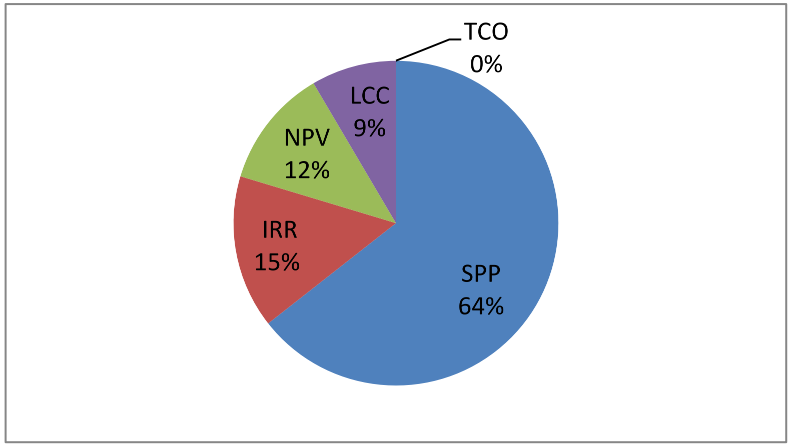
9. Is a plan made for the implementation of the identified measures?

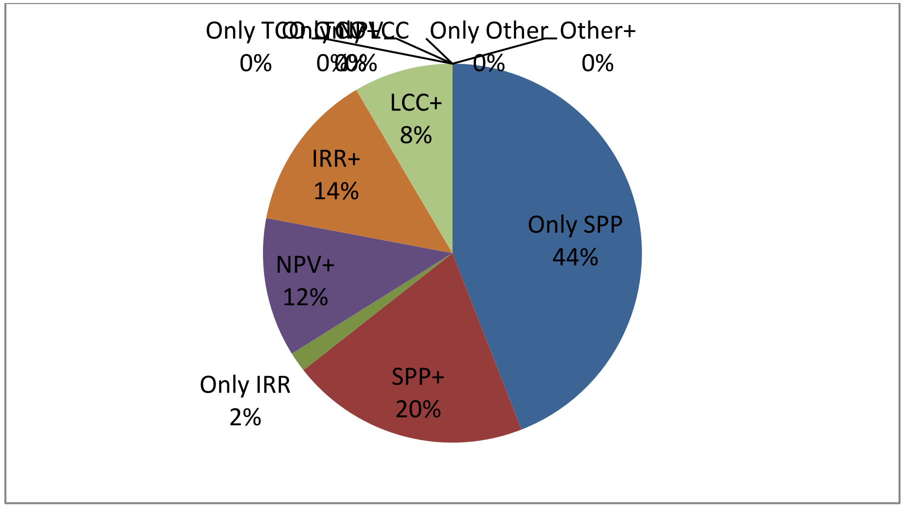


10. Are resources (time, capacity, money) allocated for the implementation?

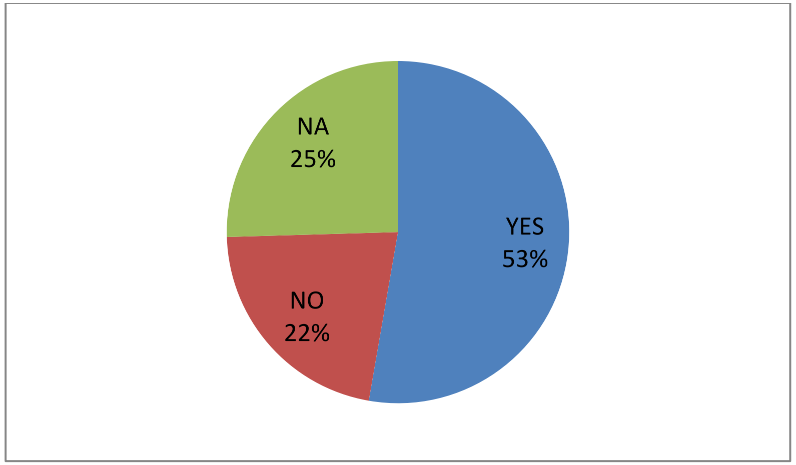


11. How is the (economic) viability of the identified measures being assessed?

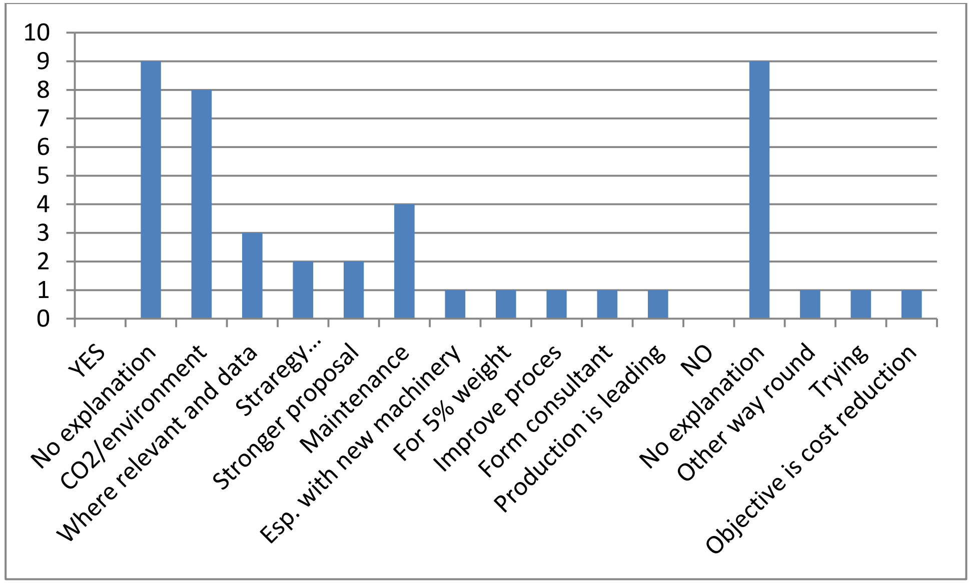




12. Are non-energy benefits accounted for when making the investment decisions?



a. If yes, how are they accounted for? b. If no, explain why?



Management Practises (questions to identify awareness for a.o. (top) management))

Answers to question 1 to 4 don't show a difference with the same questions asked earlier in the interview. Reason is that the questions regarding management practises are for most of the interviews not asked to (top-) management since they weren't available for the interviews.

1. What is the total energy use for steam production in your enterprise?

2. How does this relate to the overall energy use for production in your enterprises?

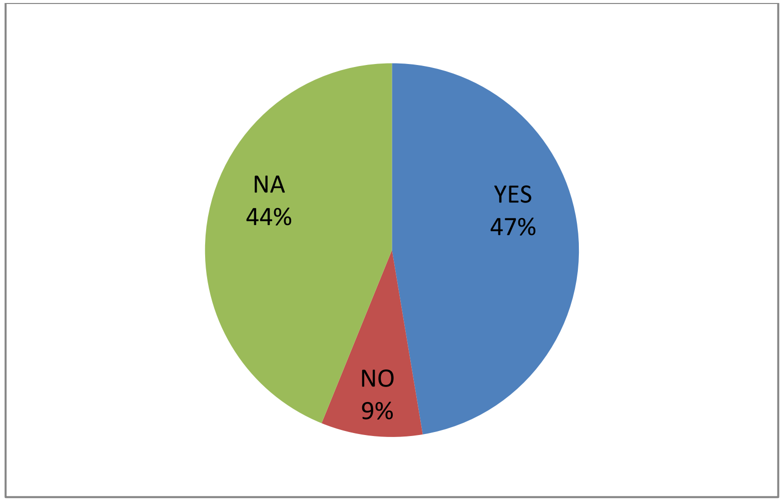
3. What are the total costs for steam production annually?

4. Do you think this can be decreased?

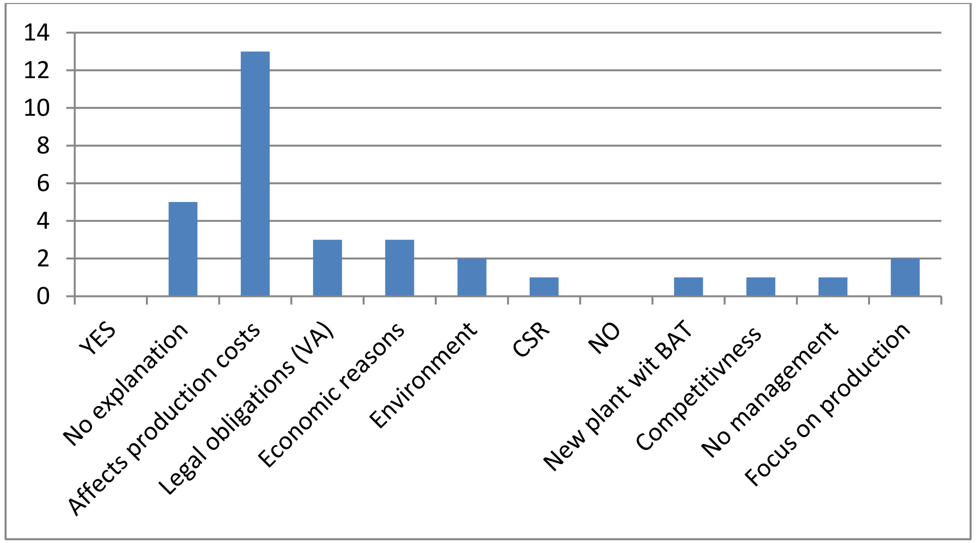
a. If no, why not?

b. If yes, can you estimate how many savings (%) can be made?

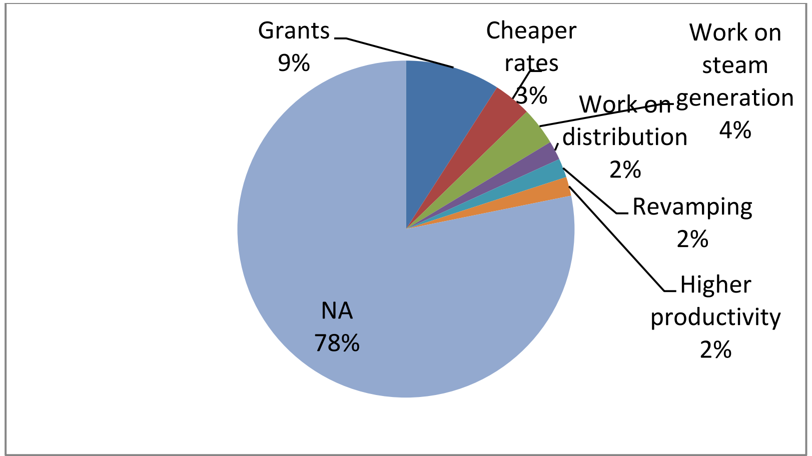
5. Is it a management priority to decrease energy use and/or cost?



a. If yes, why is this important to your organization? b. If no, explain why?

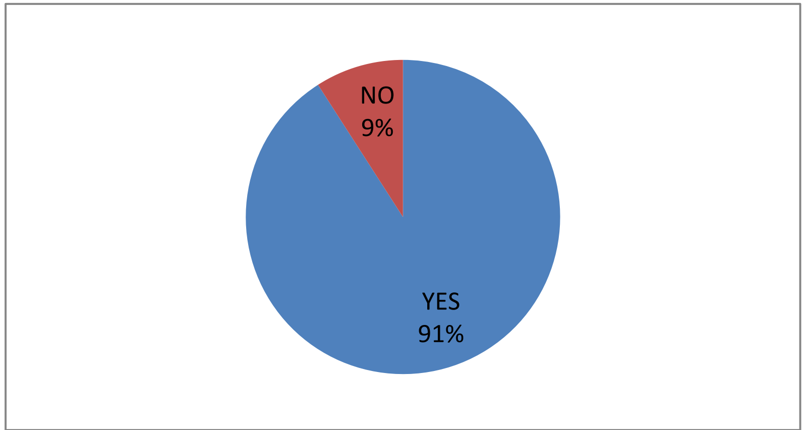


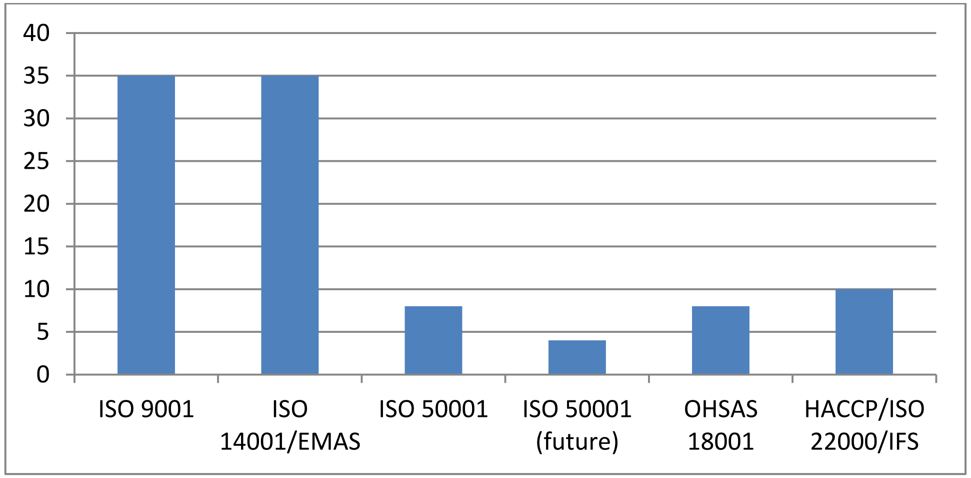
6. What would be needed for your organization to realise this decrease in energy use and/or cost?



7. How could this be organized? 50 times NA and therefore no conclusions can be made.

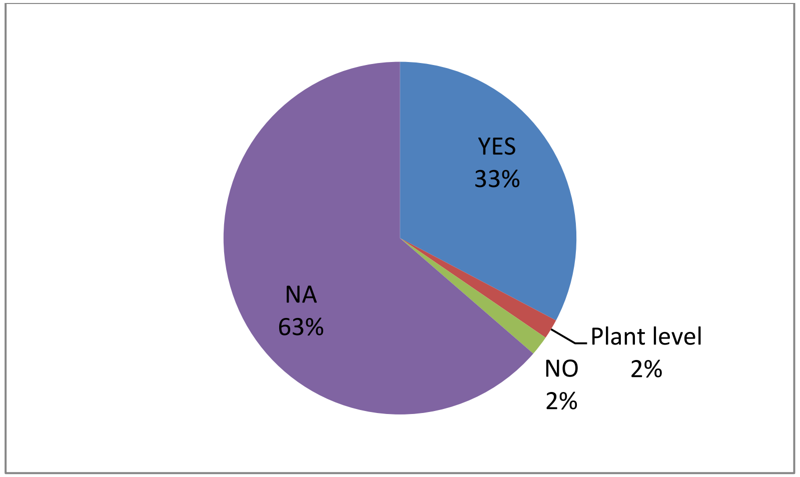
8. Does your organization have in place a management system like ISO 9001, ISO 14001, ISO 50001, ISO 22000, OHSAS 18001, others…?



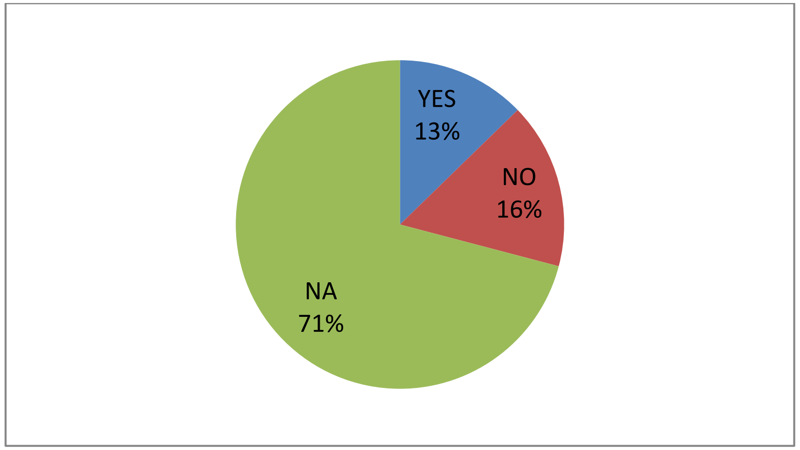


STEAM UP

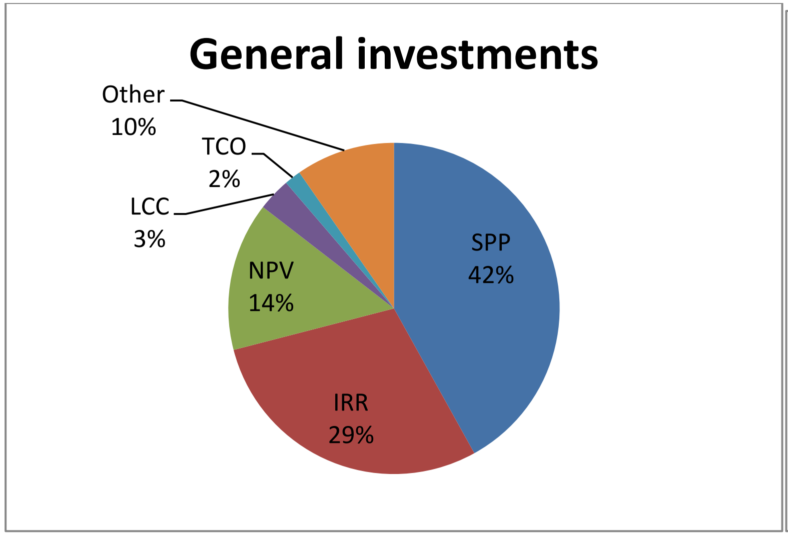
9. Is this system certified?

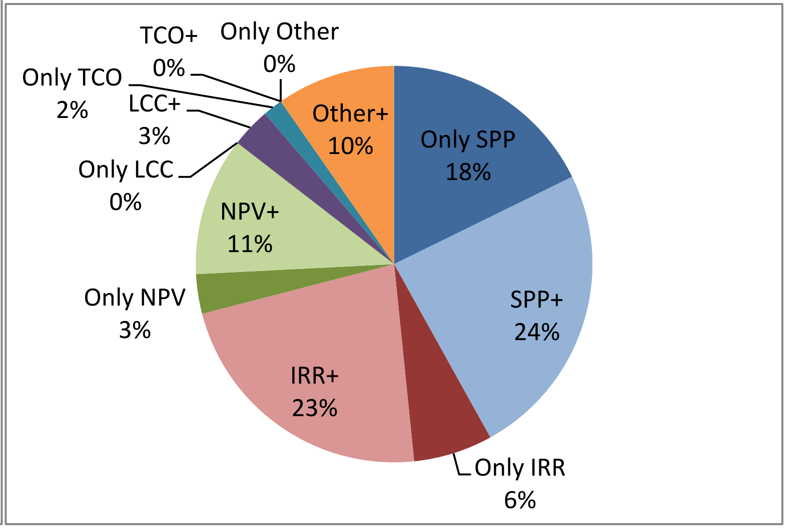


10. Is energy in one way or another addressed (or integrated) in one of these systems? (Note that requirements for ISO 50001 can easily be integrated into ISO 9001, ISO 14001 and ISO 22000)

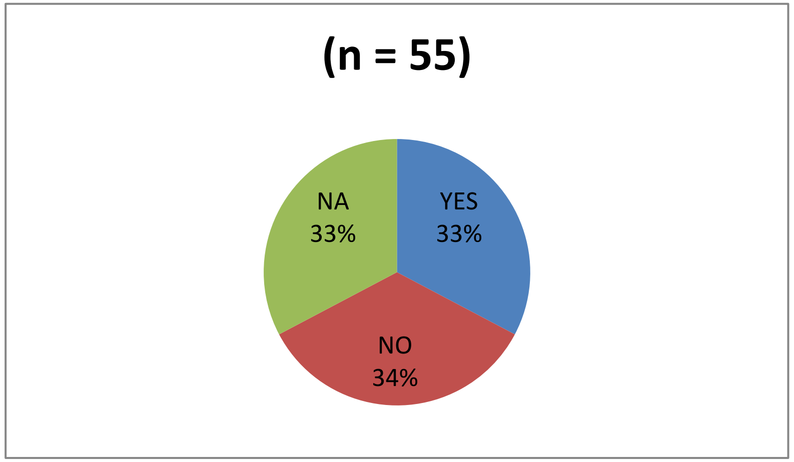


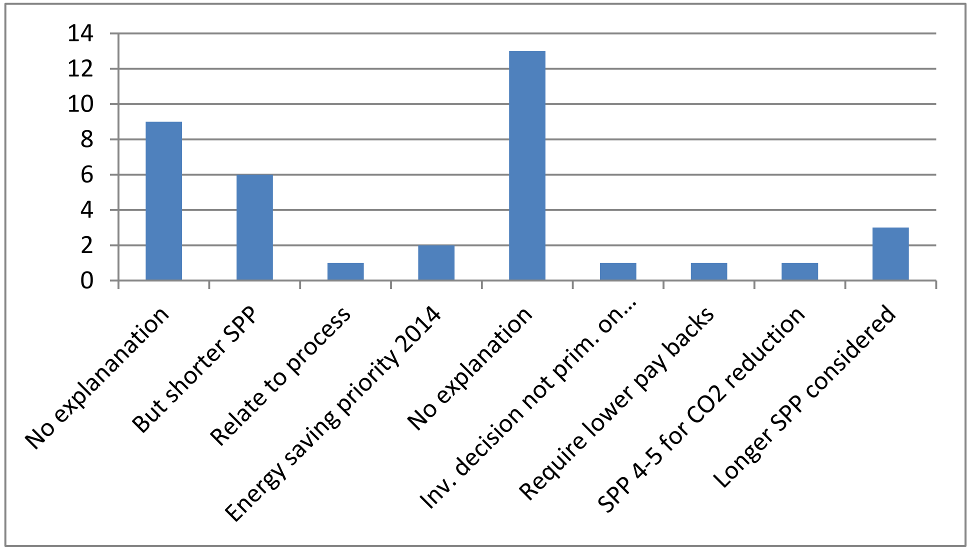
11. What financial (risk) assessment tools and methods are used in your enterprise to assess investments?



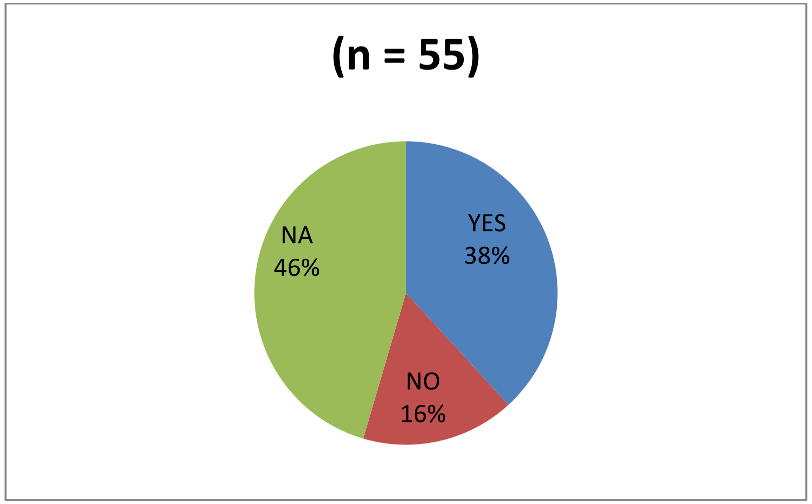


12. Are energy efficiency investments assessed in the same way as 'regular' investments?

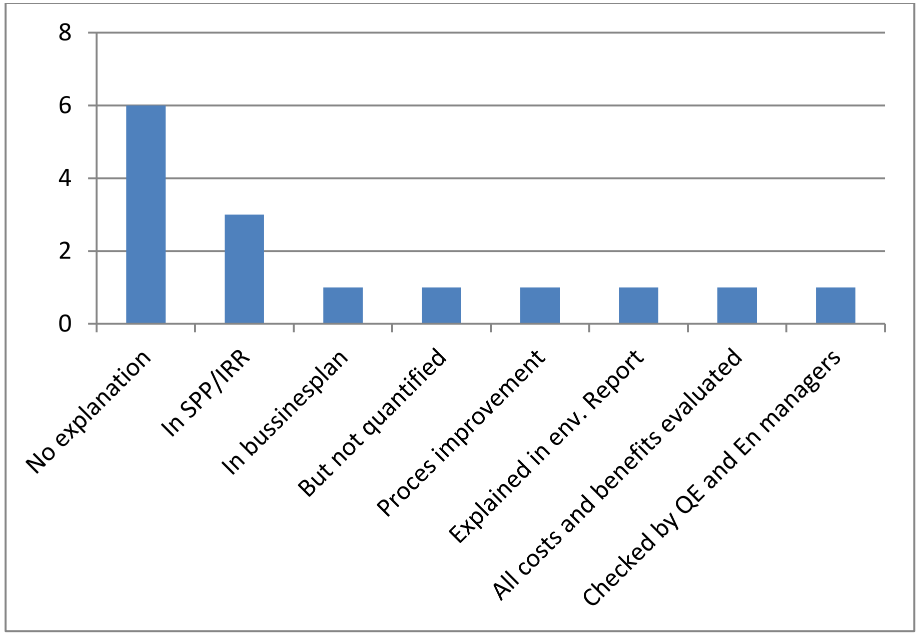


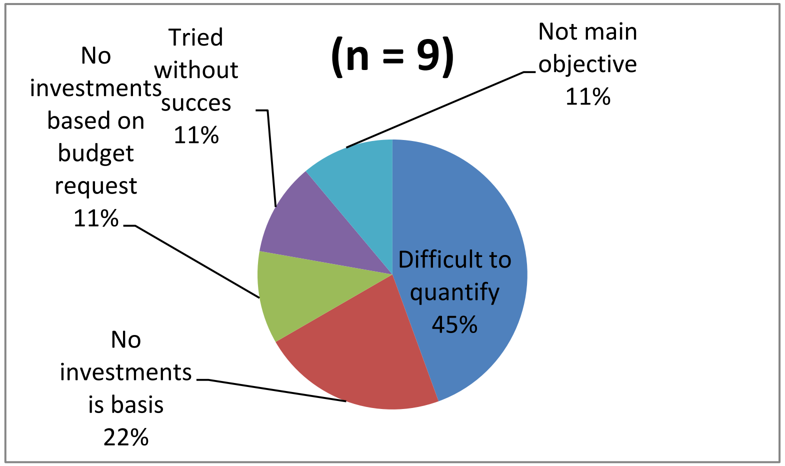


13. Are non-energy benefits accounted for when making the investment decisions?



a. If yes, how are they accounted for? b. If no, explain why?

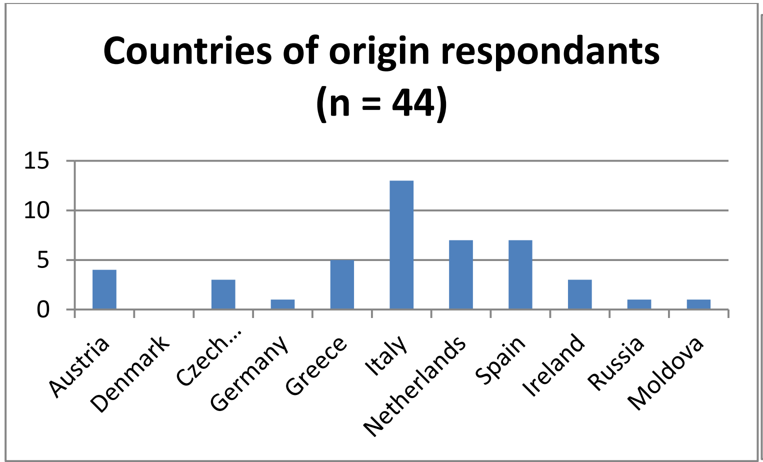


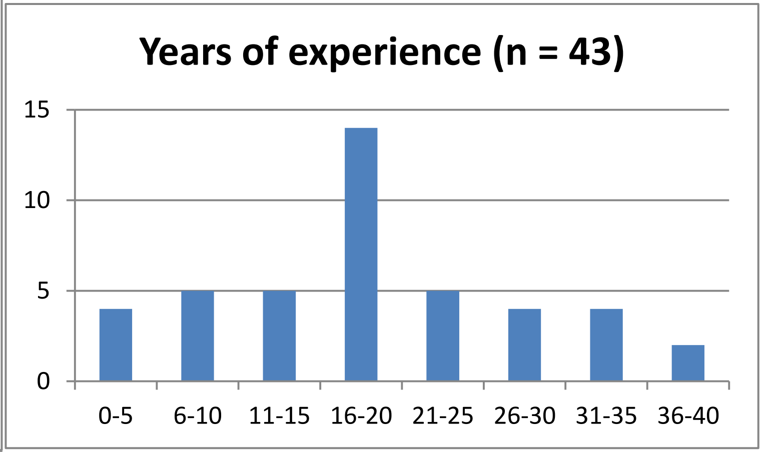


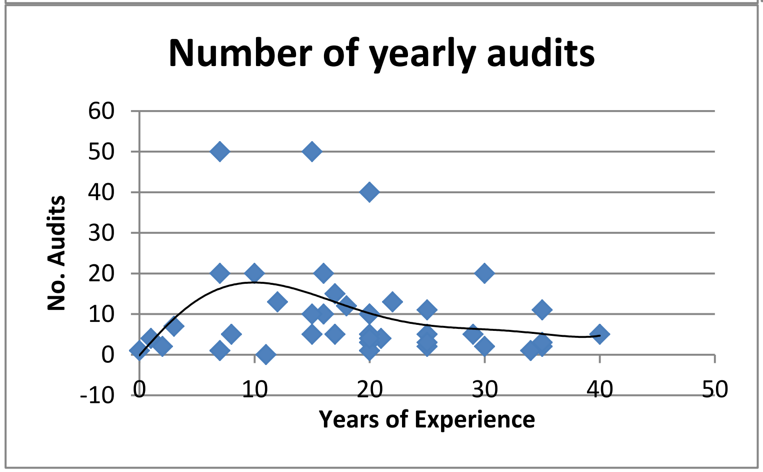
10. Appendix E: Results Energy Auditor Survey's

General information survey's

Personal information auditors

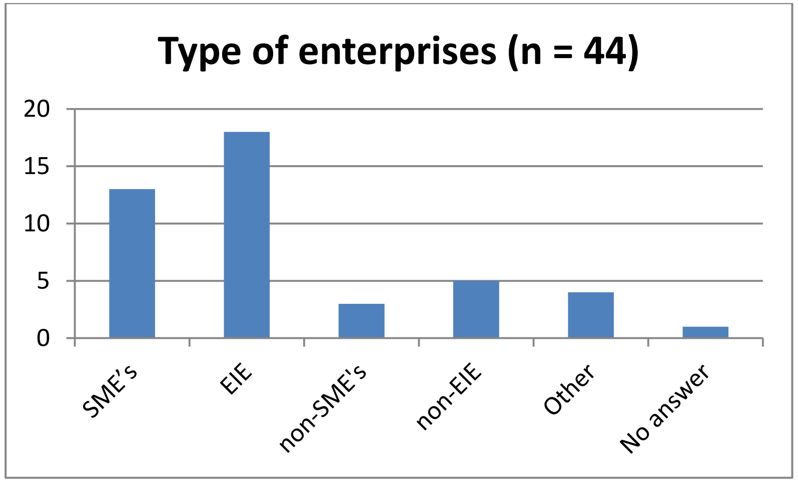




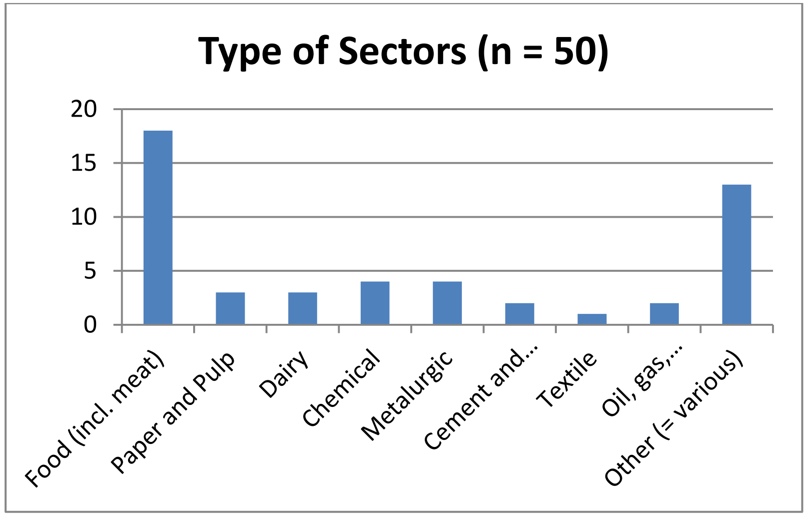


General information Audits

Q1: In what type of enterprises do you work in general?

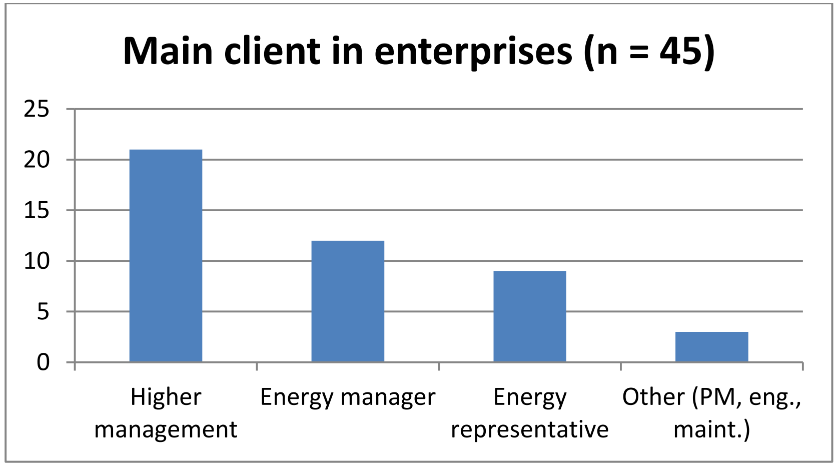


Q2: In what type of sectors do you work?

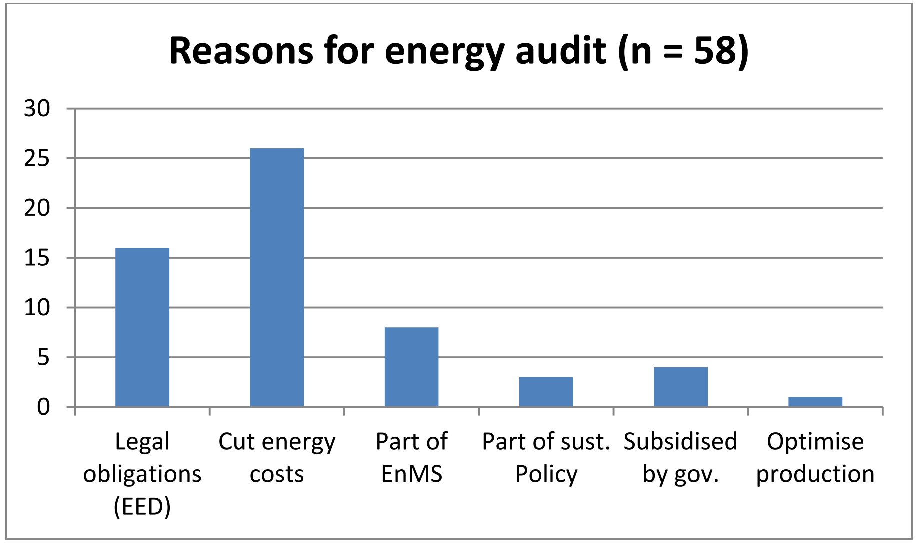


Energy audit Method and Process

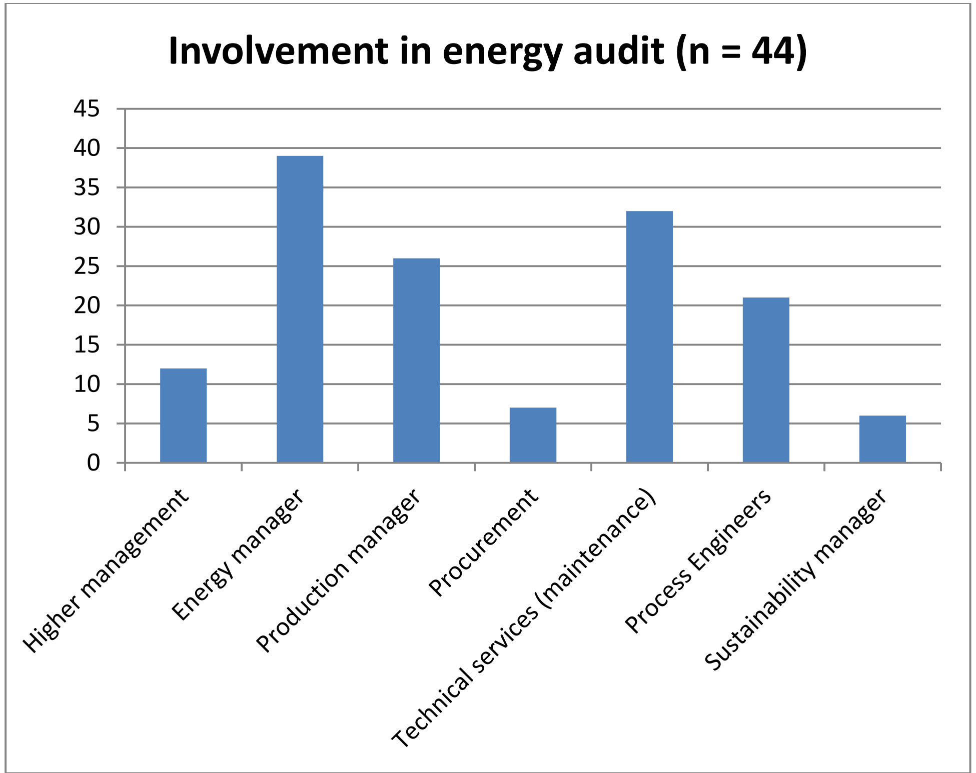
Q 1 Who is your main client in the enterprise (Who gives the order to do an energy audit)?

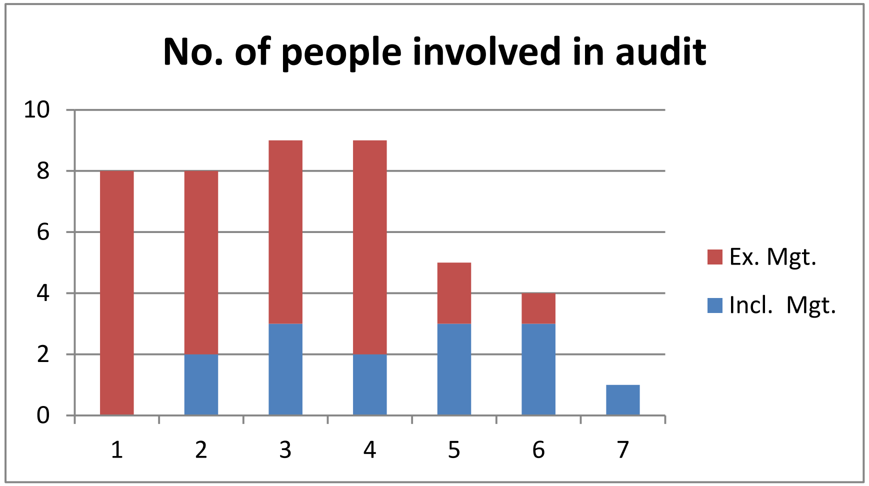


Q 2: What are the main reasons for an enterprise to do an energy audit?



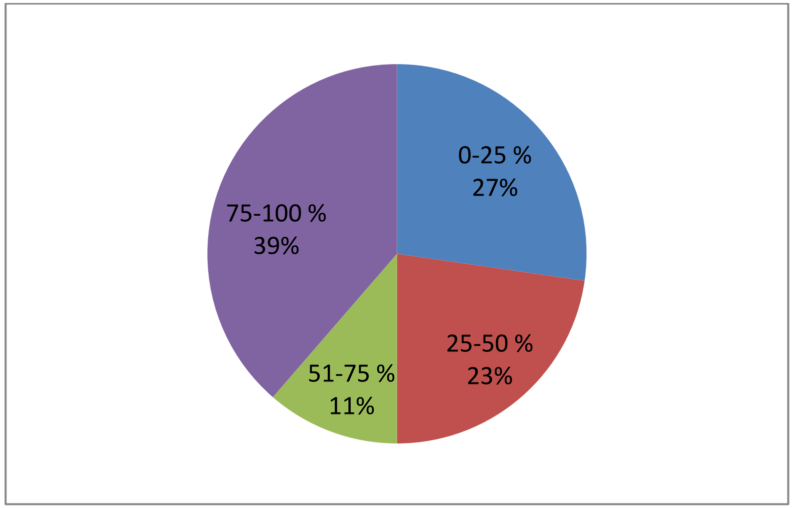
Q 3: Which people of the enterprise are generally involved in the audit process?



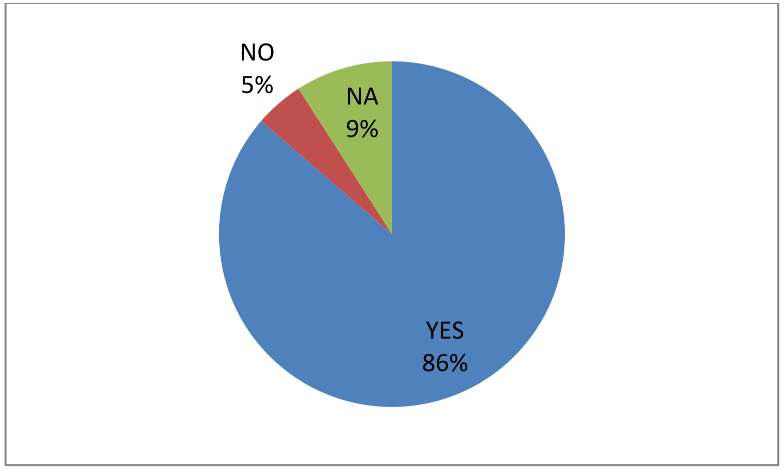


Audit on Steam System

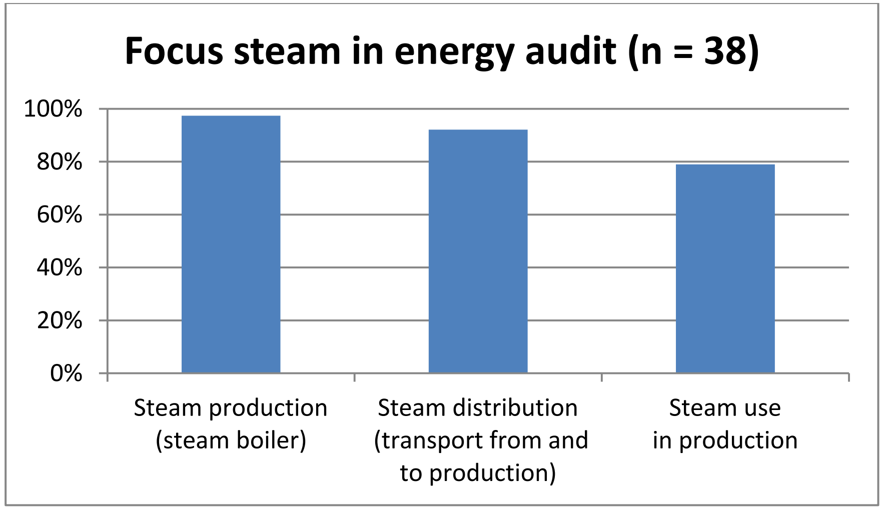
Q 1 How many of your audits include steam systems (% of total)?



Q 2 If a steam system is present in the enterprises, is the steam systems always part of the audit?



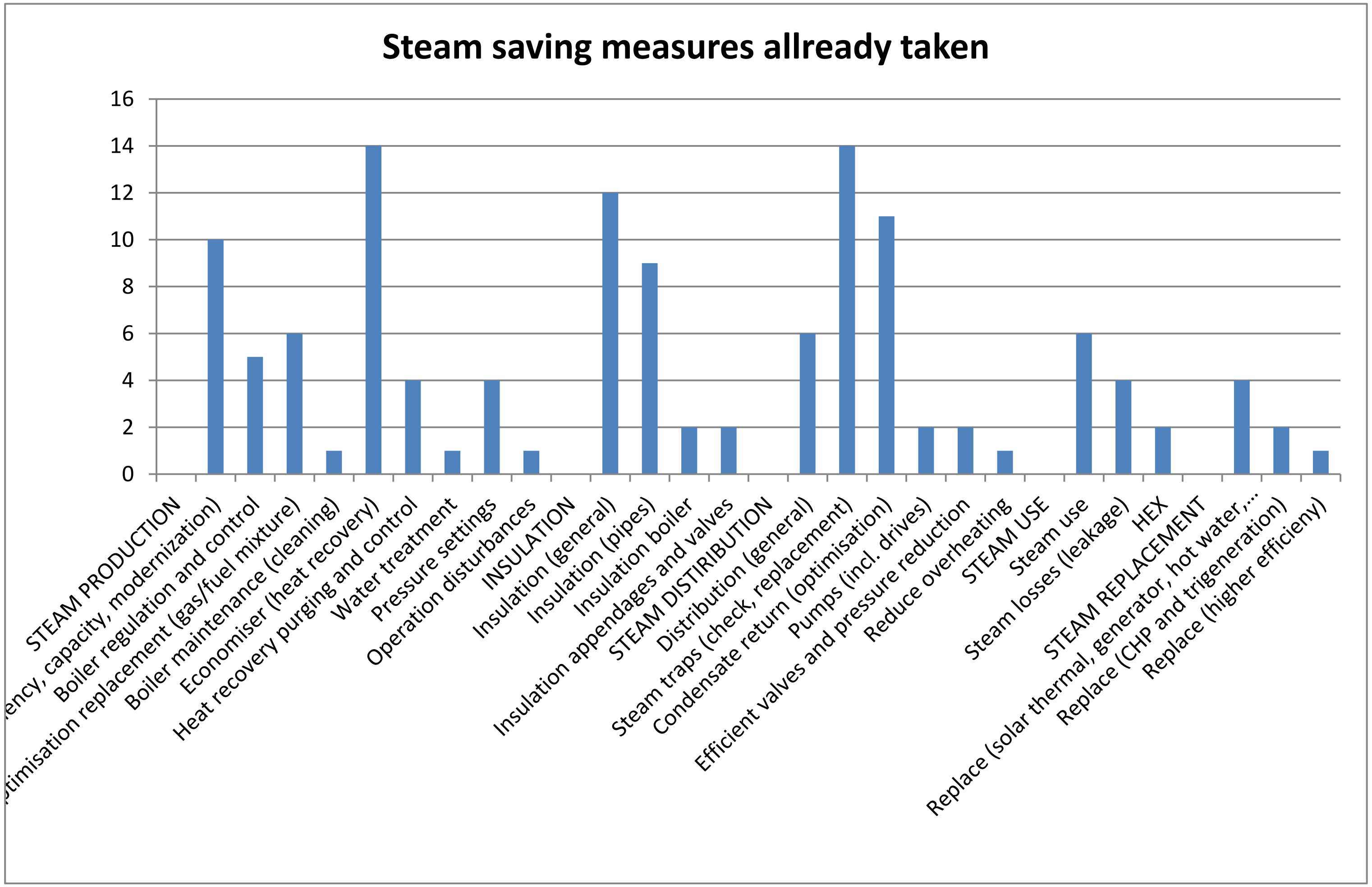
If yes, please specify which parts?



Q 3 When specific parts as described above are not audited, please explain why?

Reason for not doing distribution because it is considered negligible referred to production and use. Reason for not doing steam use is focus on production and therefore no priority.

Q 4 In the audits that you did on steam systems, what kind of energy saving measures on the steam system have generally already been taken?

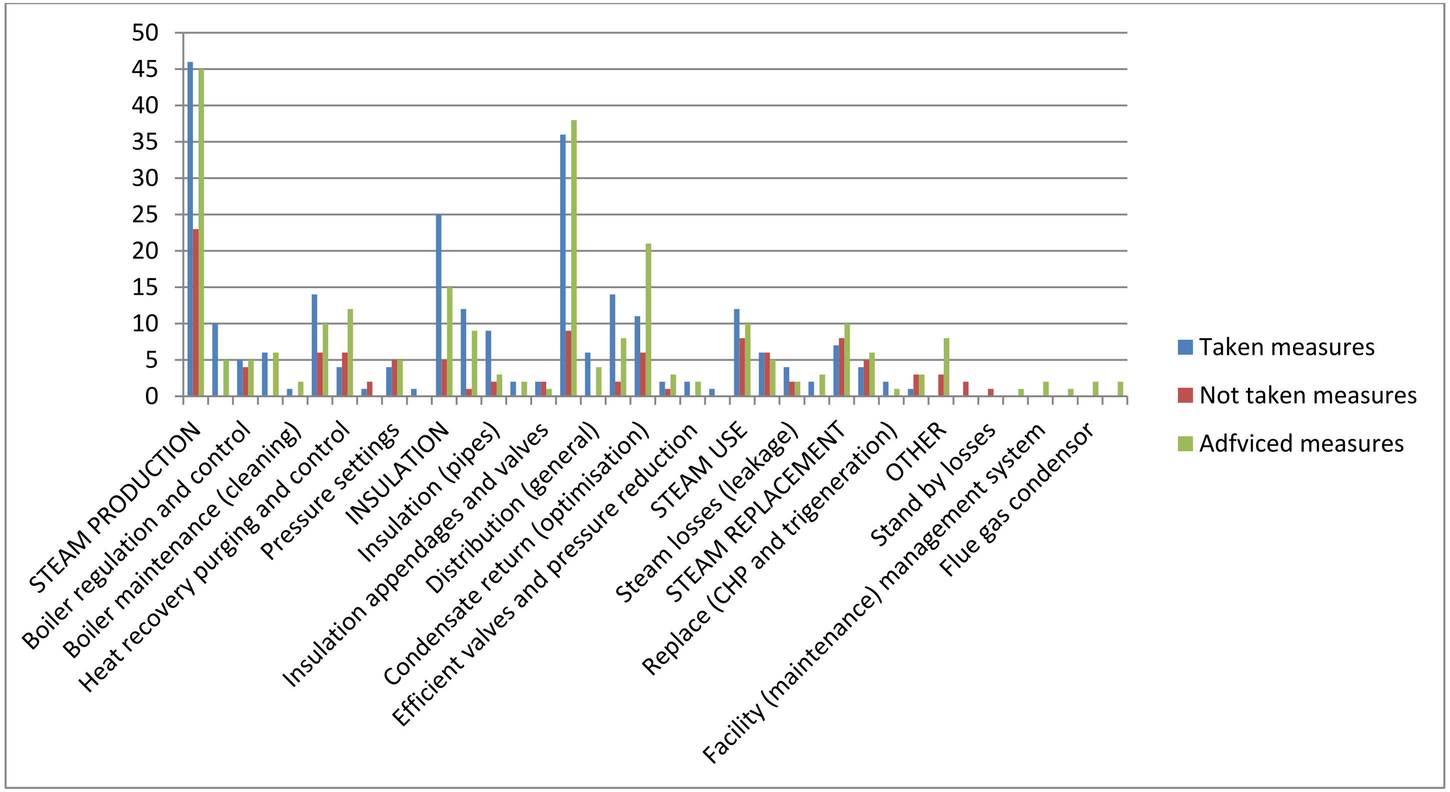


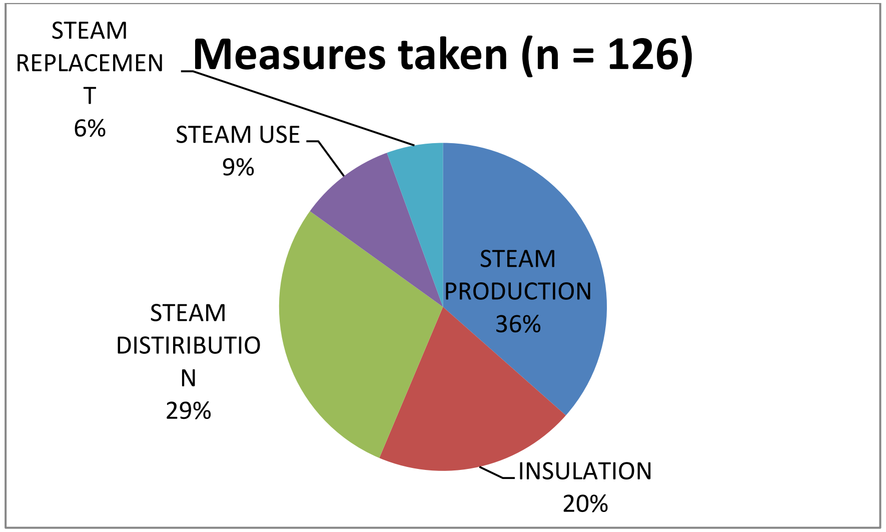
STEAM UP

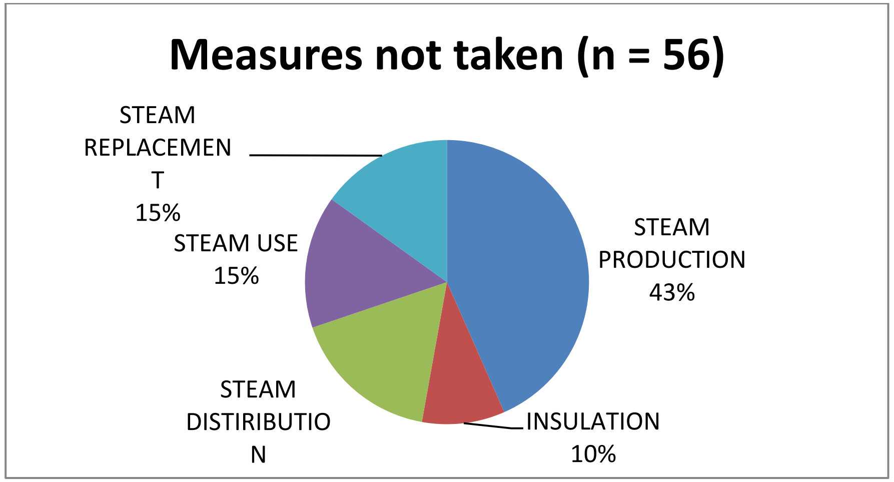
Q 5 In the audits that you did on steam systems, what kind of energy saving measures on the steam system have generally not already been taken? What is hindering the implementation of these measures?

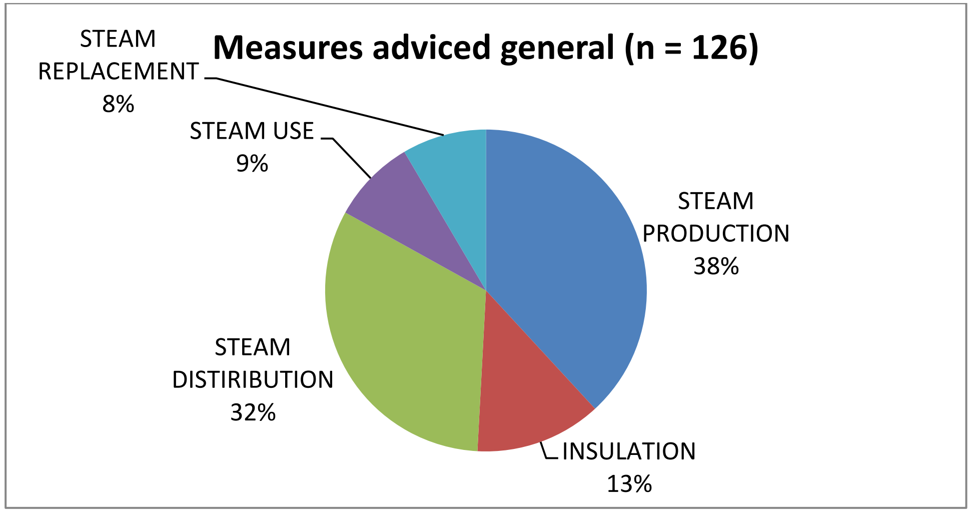
Q 6 Which steam saving measures do you generally recommend- (please mention 3)?

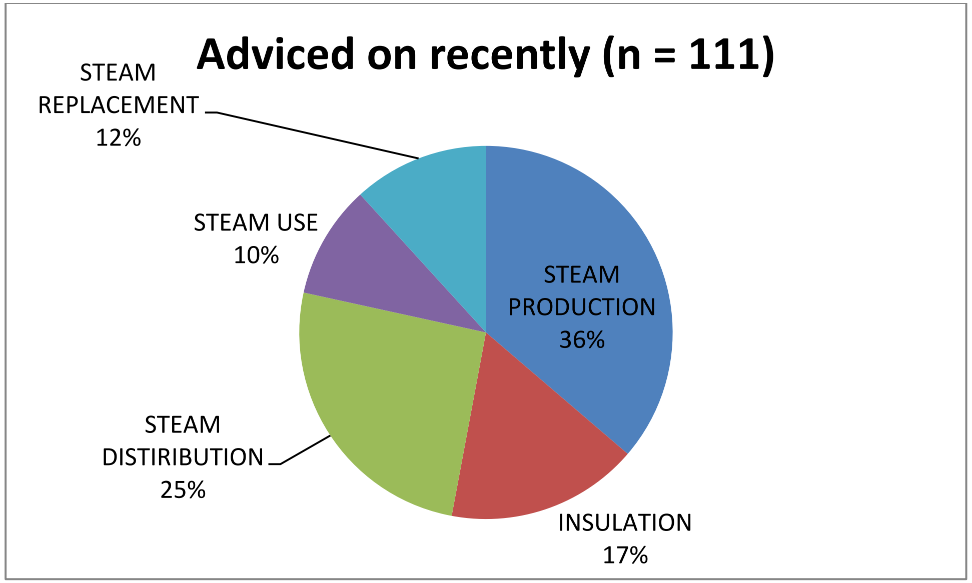
Q 7 What where your latest three recommended steam saving measures?



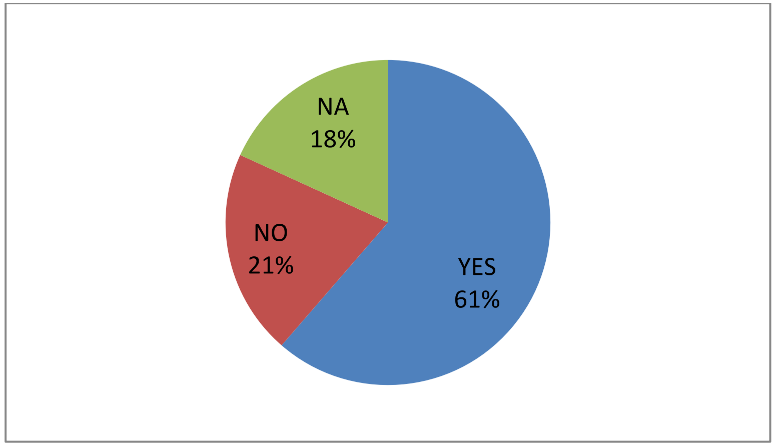

Measures taken (n = 126)
STEAM REPLACEMENT 6%
STEAM USE 9%
STEAM PRODUCTION 36%
STEAM DISTIRIBUTION 29%
INSULATION 20%


Measures not taken (n = 56)
STEAM REPLACEMENT 15%
STEAM USE 15%
STEAM PRODUCTION 43%
STEAM DISTIRIBUTION
INSULATION 10%

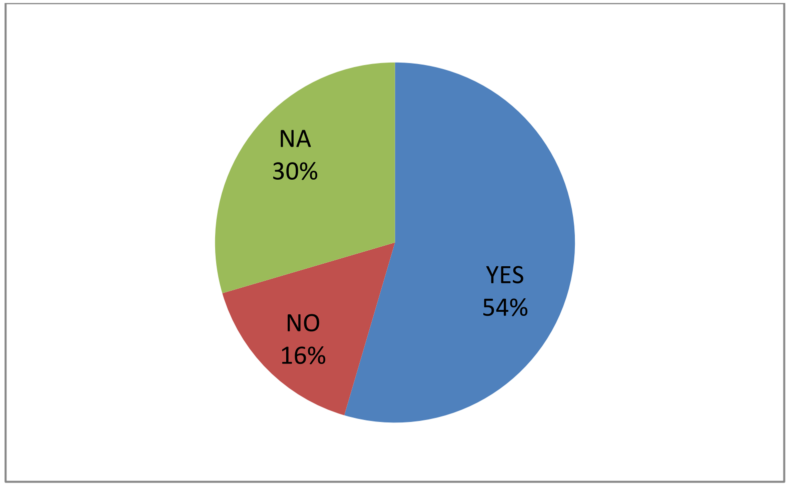

Measures adviced general (n = 126)
STEAM REPLACEMENT 8%
STEAM USE 9%
STEAM PRODUCTION 38%
STEAM DISTIRIBUTION 32%
INSULATION 13%


Adviced on recently (n = 111)
STEAM REPLACEMENT 12%
STEAM USE 10%
STEAM PRODUCTION 36%
STEAM DISTIRIBUTION 25%
INSULATION 17%

Q 8 Were they economically feasible for the enterprise (SPP < 2 years)?

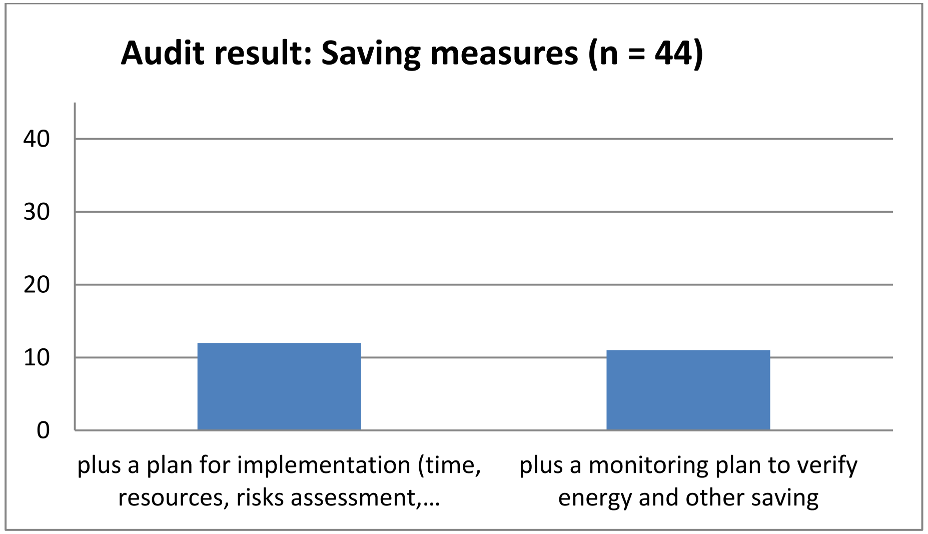


Q 9 Were they actually implemented?

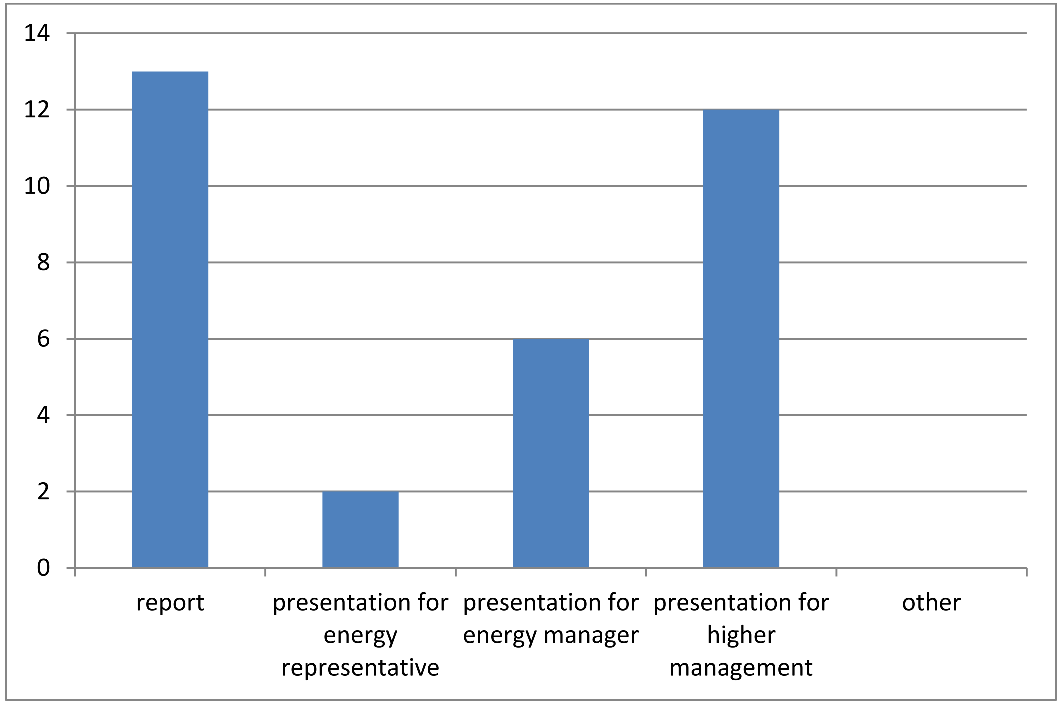


Audit results and reporting

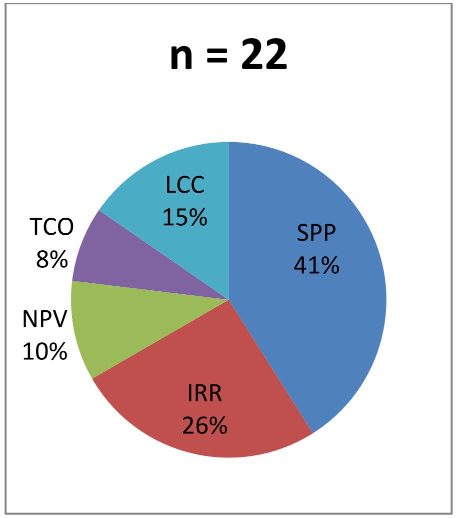
Q 1 What is the result of your audit- List of energy measures (incl. economic evaluation)?

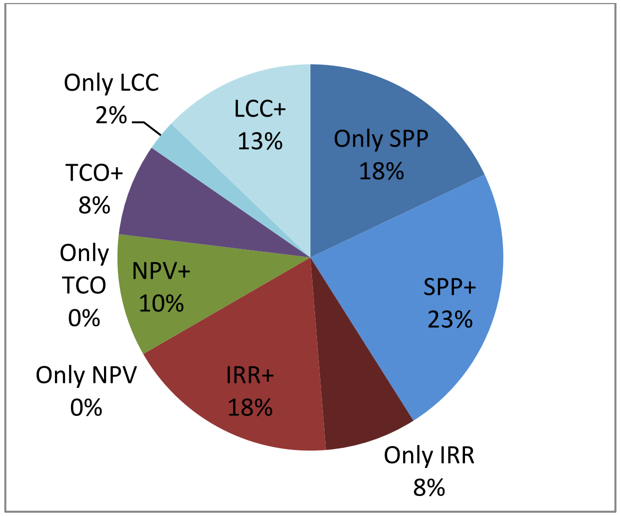


Q 2 How do you report the audit findings to the enterprise?

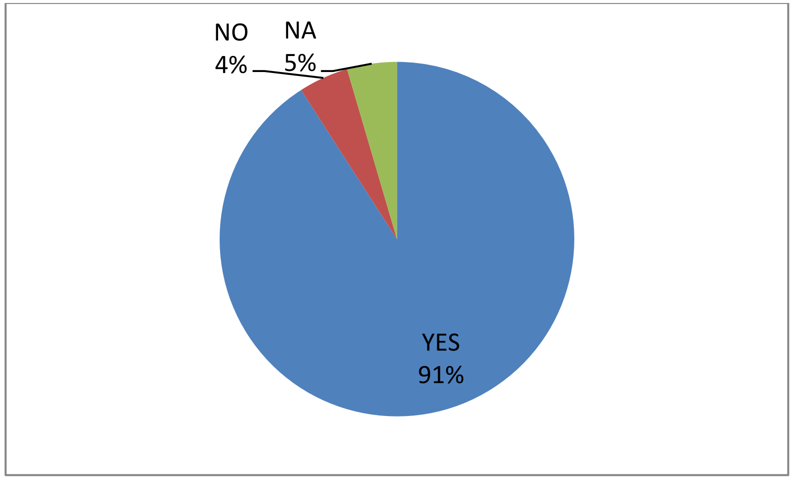


Q 3 How do you (economically) asses the identified energy saving measures

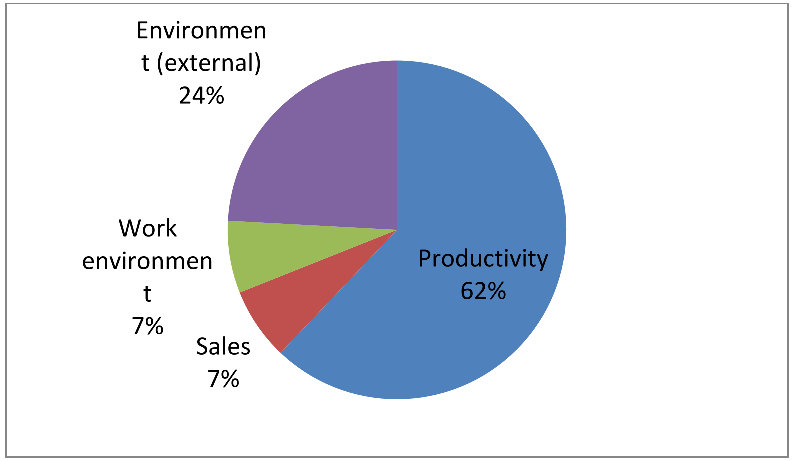




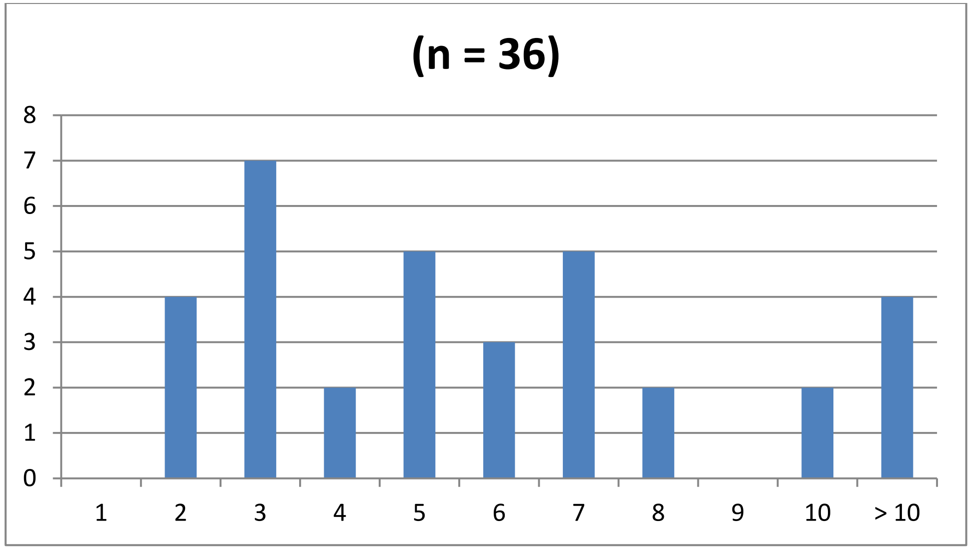
Q 4 Apart from Energy Cost Savings, are there other cost savings potentials addressed by the measures you propose?



a If no, why not? b If yes, what is the influence on actual (chance) for implementation?

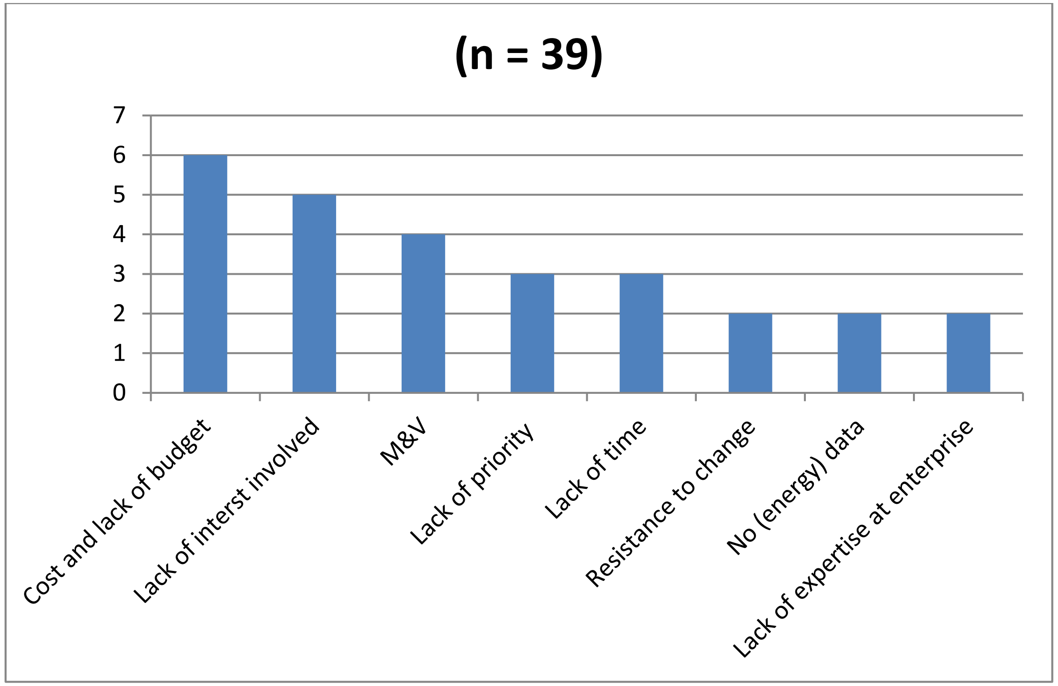


c On a scale from 1 to 10, how significant are those other savings in relation to the energy cost savings?

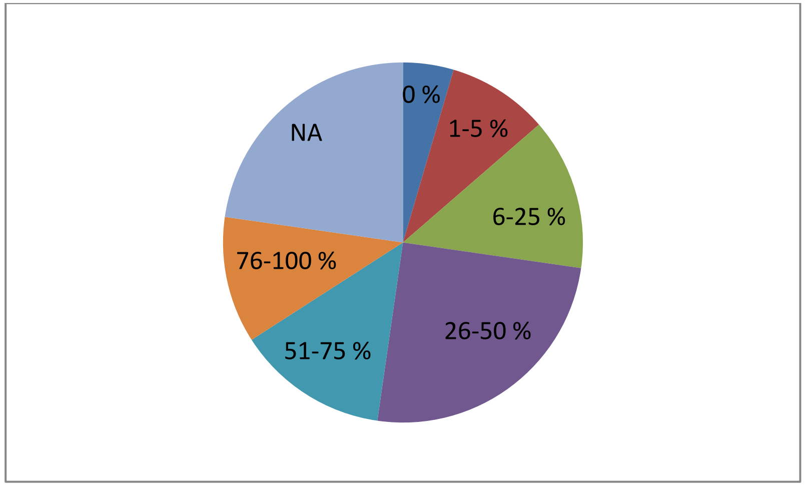


Monitoring and Follow Up of Audits

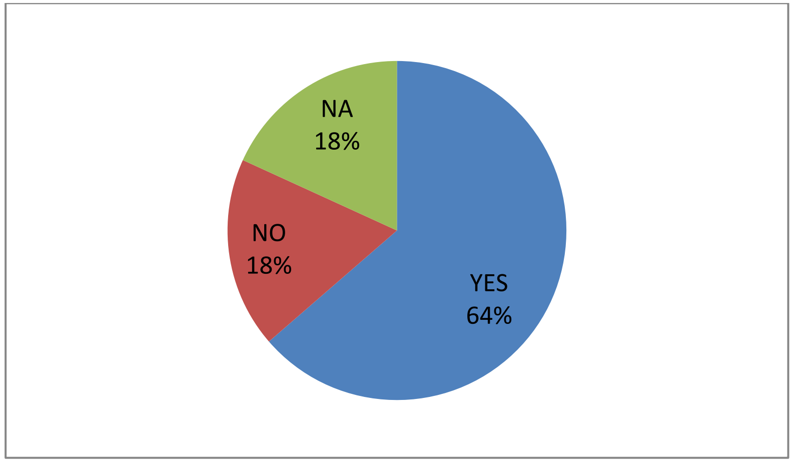
Q 1 What are the main challenges/problems you encounter in following up the audits in order to ‘check’ implementation of the identified measures?



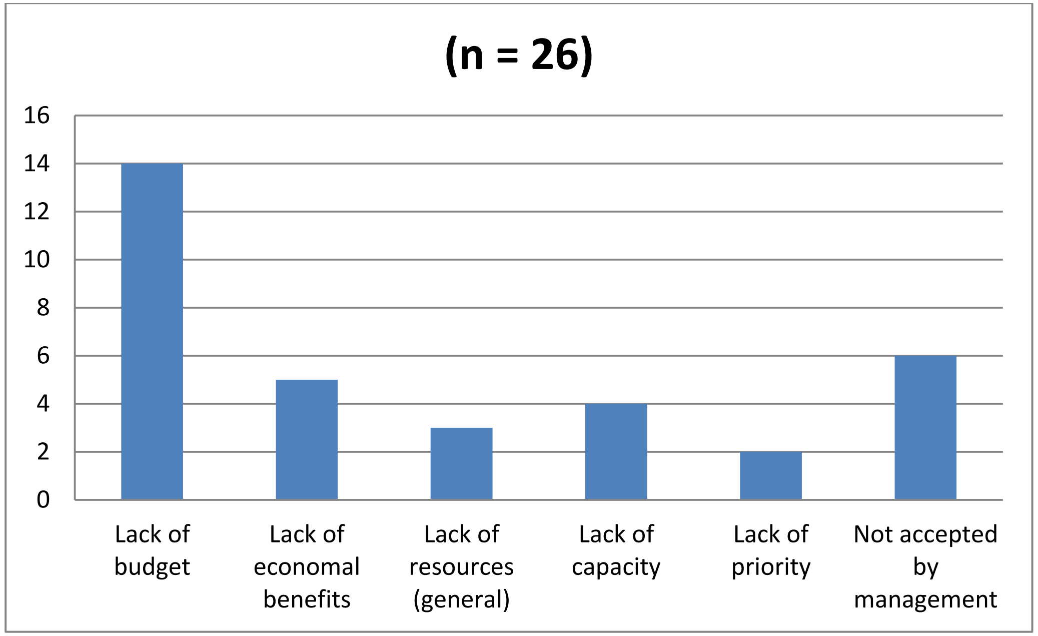
Q 2 When following up, which percentage of the economical viable measures (SPP < 2 year) are being taken after 1 year?



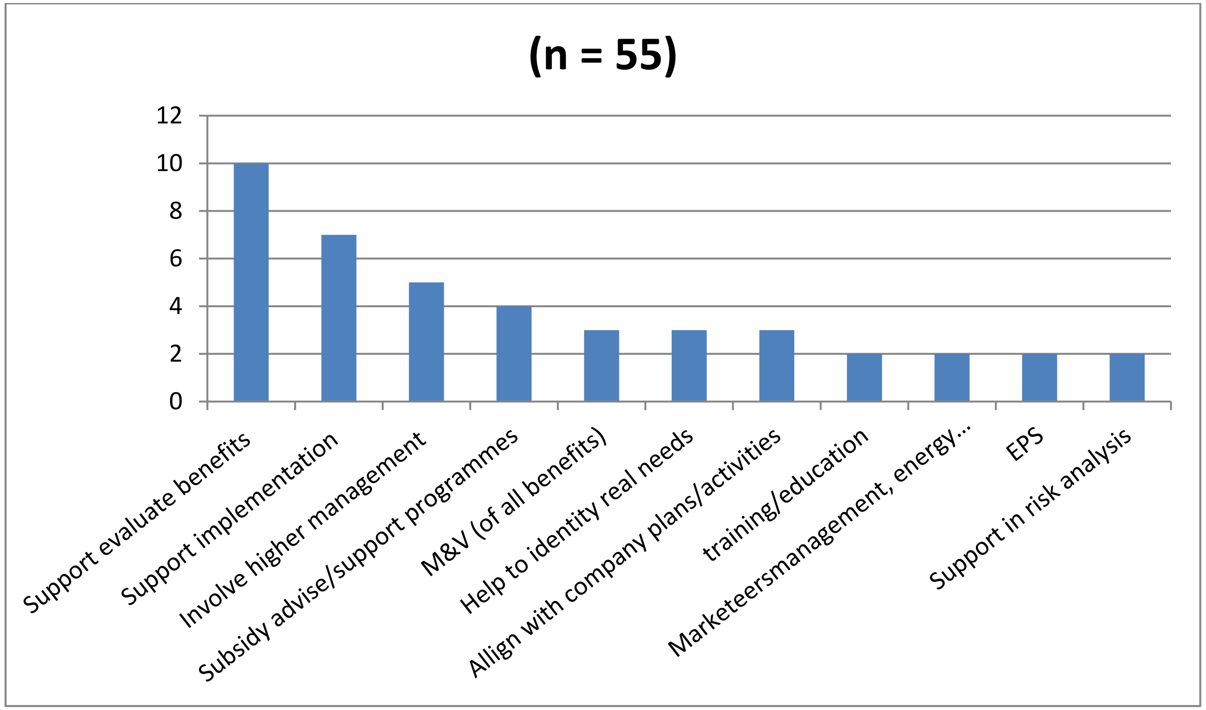
Q 3 When measures are not being taken do you get to know why?



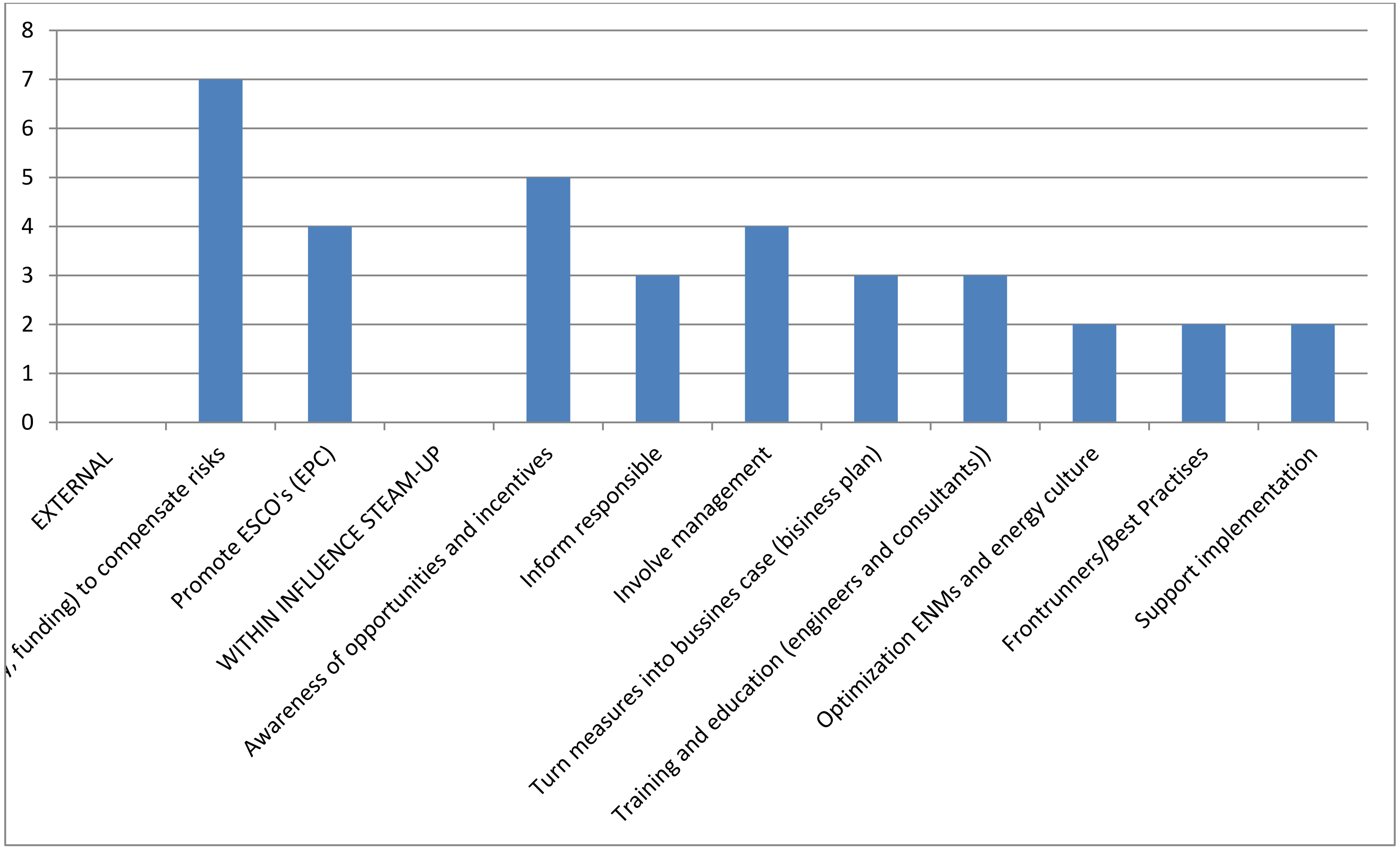
Q 4 If measures are not being taken what are the reasons communicated to you for this?


(n = 26)
16
14
12
10
8
6
4
2
0
Lack of budget
Lack of economal benefits
Lack of resources (general)
Lack of capacity
Lack of priority
Not accepted by management

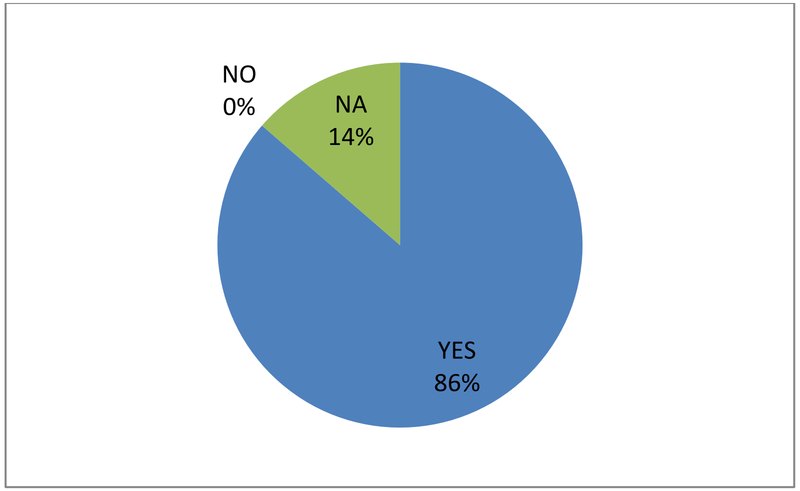
Q 5 What methods do you use in your audits to facilitate enterprises (energy representative) in getting measures implemented?



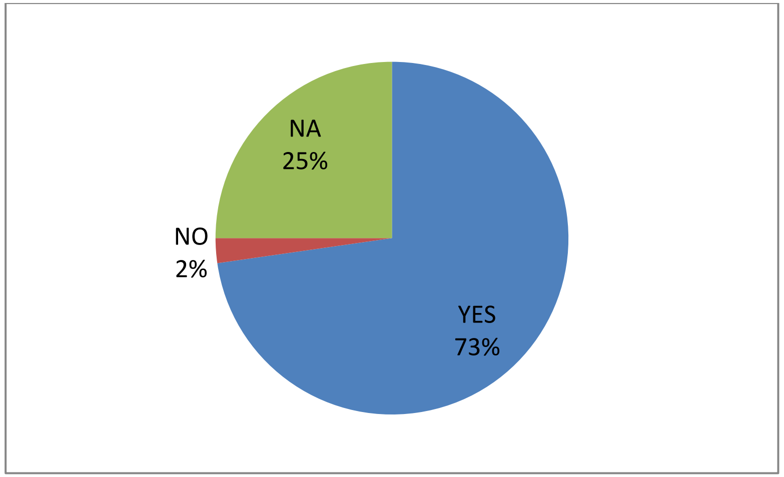
Q 6 What is in your opinion needed to enhance the implementation rate of identified energy saving measures form energy audit?


8
7
6
5
4
3
2
1
0
EXTERNAL
, funding) to compensate risks
Promote ESCO's (EPC)
WITHIN INFLUENCE STEAM-UP
Awareness of opportunities and incentives
Inform responsible
Involve management
Turn measures into bussines case (bisiness plan)
Training and education (engineers and consultants))
Optimization ENMs and energy culture
Frontrunners/Best Practises
Support implementation

Q 1 Would you be interested to be informed on the Steam Up project and its progress?



Q 2 Would you be interested to be informed on the Steam Up training courses and or networking seminars?



11. Appendix F: Collection of Tools, Methodologies, Training Materials and Information Sources

Name of the materials

1. Steam System Energy Audit Guide
2. GREENFOODS Branch Concept
3. EINSTEIN Tool-Kit
4. Chiarimenti in materia di diagnosi energetica nelle imprese
5. EFFICIENZA ENERGETICA NEL SETTORE INDUSTRIALE
6. Il Manuale delle migliori prassi per l'efficienza energetica Prassi 4 Come Migliorare le Performance del Generatore di Vapore (CARE+)
7. Steam system services – Audit
8. Diagnosi energetica
9. Energy Assessment for Steam Systems
10. Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities
11. An Energy Audit Manual and Tool
12. Energy Potential Scan
13. Generiek Stoommodel (Eng.: Generic Steam model)
14. Model Stoomkosten (Eng.: Steam costs Model)
15. Rekensheet Methode stand by (Eng.: Excel sheet for stand by steam boiler
16. Industrial Steam System Optimization (SSO) Experts Training
17. Steam System Survey Guide
18. Carbon Trust (2003): ECG066, Energy Consumption Guide, Steam Generation Costs 2003 (Update), Actionenergy from Carbon Trust
19. Carbon Trust (2004) ECG092, Energy Consumption Guide, Steam Distribution Costs, 2004 (Update), Actionenergy from Carbon Trust
20. Europäische Kommission (2009): Reference Documents on Best Available Techniques on Energy Efficiency
21. University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 2, Boilers and Furnaces, The Energy Research Institute
22. University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 5, Steam Systems, The Energy Research Institute
23. University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 6, Insulation, The Energy Research Institute
24. Grundlagen der Dampf- und Kondensattechnologie
25. Spirax Sarco (2007). Leitfaden für die Gestaltung von Dampf- und Kondensatnetzen, die Auswahl und den Einbau von Kondensatableitern, die Fehlersuche in Dampf- und Kondensatnetzen, den Betrieb von Dampf- und Kondensatanlagen, Konstanz
26. Sattler, P., Fuchsberger, K., Hinterndorfer, M,: Einsparpotentiale in der industriellen Dampferzeugung und –anwendung im Auftrag des Landesenergieverein Steiermark, 2009
27. Heat Module of the European Energy Manager (EUREM) Course
28. Greenfoods Training – Heating Systems and Optimisation
29. Thermo- technic plants
30. Lesson of 'Study and utilization steam'
31. Lesson of 'The heat exchange and heat exchangers'
32. Lesson of 'Energy use in industry' – Steam generator
33. Lesson of 'Heat recovery Steam generator'
34. Modern Industrial Assessments: A Training Manual
35. Best Practice Steam

36. Steam System Assessment report sample (UNIDO) (available at RVO)
37. Steam System Supply Cost Curve report (UNIDO) (available at RVO)
38. Energy Management Expert Training (UNIDO) (available at RVO)
39. Non Energy Benefit Tool (available at AURA)
40. Guiding for identifying Non Energy Benefits (available at AURA)
41. Assessment tool for steam production and distribution using industrial waste heat (http://www.rvo.nl/stoom-tool-new)
42. Ecodesign Preparatiry Study on Steam Biliers http://www.eco-steamboilers.eu/eco-steamboilers-wAssets/docs/20141217-Steam-Boilers-Ecodesign-Final-Report.pdf
43. CALCULATION TOOL ASSESSING THE IMPACT OF VARIOUS ENERGY CONSERVATION MEASURES ON FINANCIAL ACCOUNTS http://www.leonardo-energy.org/tools-and-tutorials/calculation-tool-assessing-impact-various-energy-conservation-measures-financial

Table 1.: Overview of tools, methodologies,...and their characteristics

Name	Language	Public	Self Guidng	**STEAM**	Productionnn	Steam D	Steam Use	Technologies	Operation	Control	GHK	Monitroing	Other	**AUDITING**	Mangament Commitment	Mapping Energy Use	Task, Responsibilities	Assesment of production	Operational Control	M&V	EnPI	EnMs	Identification of Measures	Financial Assesment	Non Energy Benefits	Other
Tools and methodologies for steam and energy auditing																										
1	Ge	x	x		x	x	x	x	x	x	x					x		x			x		x			
2	En	x	x		x	x	x									x		x			x	x	x		x	
3	En	x	x		x	x	x	x	x	x														x		
4	It	x	x																							
5	It	x	x										A			x		x		x	x	x	x	x		
6	It/En	X	x		x	x	x	x	x	x			A			x		x		x	x	x	x	x		A
7	It/En	X			x	x							B							x			x	x		A
8	It	x	x												x	x	x	x	x	x	x	x	x	x		
9	En	x	x		x	x	x						C			x		x	x	x		x	x			C
10	En	x	x		x	x	x						D		x	x	x	x	x	x	x	x	x			E
11	En	x	x		x	x	x						F			x	x	x	x	x	x	x	x			G
12	En	x													x	x	x		x	x	x	x				H

13	En/Nl	x	?		x	x	x	x	x							x					x					
14	Nl	x	x		x				x							x					x					
15	Nl				x				x		x		I													
Name	Language	Public	Self Guidng	**STEAM**	Steam Productionn	Steam Distribution	Steam Use	Technologies	Operation	Control	GHK	Monitroing	Other	**AUDITING**	Mangament Commitment	Mapping Energy Use	Task, Responsibilities	Assesment of production	Operational Control	M&V	EnPI	EnMs	Identification of Measures	Financial Assesment	Non Energy Benefits	Other
Information sources and training materials for steam and energy auditing																										
16	En	x	?		x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x		
17	En	N			x	x	x	x	x	x	x	x							x		x		x			
18	En																									
19	En																									
20	En																									
21	En																									
22	En																									
23	En																									
24	Ge	x	?		x	x	x	x	x	x	x	x							x				x			

25	Ge																									
26	Ge																									
27	E	N			x		x	x	x	x		x							x				x			
28	En	N			x			x	x	x		x							x				x	x	x	
29	It	N			x	x	x	x																		
30	It/En	N			x	x		x																		
31	It/En	N			x	x	x	x																		
32	It	N			x	x		x					J													
33	It	x			?	?	?						J													
34	En	x											K													
35	NL	x	x		x	x	x	x	x	x	x	x	L													
36	En	N[1]	?																							
37	En	N[1]	?																							
38	En	N[1]	?												x	x	x	x	x	x	x	x	x	x		M
39	DK	x	x																						x	N
40	En	x	x																						x	O
41	NL	x	x										P													

1. In close consultation with owner UNIDO, who is an associate partner in the Steam-Up project, can use of this material for the Steam-Up project be discusses

Explanation notes in Table 1

A. General approach for industrial energy auditing, including casa studies, of which the heat recovering from steam boiler

B. General approach for steam energy auditing
C. American National standard for energy assessment of steam systems, which defines the standardised approach for implementing energy audit of steam systems, indicates also a number of useful software tools as key references, for instance, Steam System Assessment Tool
D. EE improvement opportunities in steam systems
E. List of sector-specific energy-efficiency improvement opportunities for selected industrial sectors, including Textile and Fruit-vegetable processing industries where exist steam systems.
F. Good practices
G. A step-by-step guide to the audit methodology
H. Includes a specific approach were all stakeholders, that have an influence on the implementation of energy efficiency, are involved in the audit
I. Specific model to calculate ‘stand by’ energy use for a steam boiler
J. All principles and technology development of steam generator
K. Boiler energy assessment methodology
L. Energy Saving
M. Includes all aspects for implementation if an energy management system according to ISO 50001
N. Web based Tool with Best Practises of the use of non-energy benefits
O. Guiding instruction for auditors for identifying relevant non energy benefits in the auditing process
P. Assessment tool for using industrial waste heat for steam production (including distribution to the vicinity)

12.

F.1 Tools and Methodologies

General information					
1					
Name:	Steam System Energy Audit Guide				
Region:	Austria	Year:	Update 2013 (2010)		
Author/s:	Konstantin Kulterer	Editor/s:	Austrian Energy Agency		
Languag e/s:	German	Format:	pdf		
Link:	http://www.klimaaktiv.at/energiesparen/betriebe_prozesse/technologieschwerpunkte/dampfsysteme.html				
Accessibility and ease of use					
Public available:	Yes:X		No:		
Comments:					
Self-guiding:	Yes:X		No:		
Comments:					
Conformity with National/Local legislation or Standards					
Name:	EN 16247-1 (partly) as it is more technical EN 16247-3 (partly)				
Region:	National		Local:		
Authority:					
Conformity:	Yes:		No:		
Comments:					
Conformity with European legislation or (International) Standards					
Name:					
Region:	European:		International:		

Authority:				
Conformity:	Yes:		No:	
Comments:				
Aspects covered: STEAM (mark with an "X" and specify when required)				
Steam Production				X
Steam Distribution				X
Steam Use				X
Subject:				
Technologies				X
Operation				X
Control				X
Good House Keeping (incl. maintenance, parameter setting,…)				X
Monitoring				
Others *Please specify:*				
Aspects covered: Energy Auditing (mark with an "X" and specify when required)				
Management commitment (policy, resources,…)				
Mapping of Energy Use (Energy Flows, Energy Balance,…)				X
Tasks, Responsibilities, Authorities				
Assessment of production processes and utilities				X
Operational Control (incl. maintenance)				
Monitoring and Verification				
(Energy) Performance Indicators				X
Energy Management System				
Identification of Energy Efficiency Measures				X
Financial Assessment and Procedures (SPP, LCC, IRR,…)				

Non Energy Benefits	
Others Energy Saving formula for around 10 different energy saving options. *Please specify*	
Material content	

Please summarize the content (table of content):

-

General information					
2					
Name:	GREENFOODS Branch Concept				
Region:	Austria		Year:	2015	
Author/s:	AEE (Austrian Energy Agency) – Institute for Sustainable Technologies		Editor/s:	AEE	
Language/s:	English		Format:		
Link:	http://www.green-foods.eu/greenfoods-branch-concept-2/				
Accessibility and ease of use					
Public available:	Yes: X			No:	
Comments:	Branch Concept latest version available in GREENFOODS project web (http://www.green-foods.eu/)				
Self-guiding:	Yes: X			No:	
Comments:	Easy to use as you have explanation and guiding via textbox throughout the data introduction process. Besides, The user is supported by the GREENFOODS WikiWeb, a compendium of up-to-date and innovative information on energy efficiency in the targeted sub-sectors of the European Food and Beverage industry.				
Conformity with National/Local legislation or Standards					
Name:					
Region:	National			Local:	
Authority:					
Conformity:	Yes:			No:	
Comments:	Not applied				
Conformity with European legislation or (International) Standards					
Name:					
Region:	European:			International:	
Authority:					

Conformity:	Yes:		No:	
Comments:	Not applied			
Aspects covered: STEAM (mark with an "X" and specify when required)				
Steam Production				X
Steam Distribution				X
Steam Use				X
Subject:				
Technologies				X
Operation				X
Control				
Good House Keeping (incl. maintenance, parameter setting,…)				
Monitoring				
Others *Please specify:*				
Aspects covered: Energy Auditing (mark with an "X" and specify when required)				
Management commitment (policy, resources,…)				
Mapping of Energy Use (Energy Flows, Energy Balance,…)				X
Tasks, Responsibilities, Authorities				
Assessment of production processes and utilities				X
Operational Control (incl. maintenance)				
Monitoring and Verification				
(Energy) Performance Indicators				X
Energy Management System				X
Identification of Energy Efficiency Measures				X
Financial Assessment and Procedures (SPP, LCC, IRR,…)				
Non Energy Benefits				X
Others *Please specify*				

Material content
The GREENFOODS branch concept is an energy audit and energy management tool as well as a realization guideline for companies of the food and beverage industry. You can design the boilers using different fuels and introducing the operation data so that steam can be produced. As regards steam distribution, it is only possible to set the distribution losses. Finally, you have to select the technology that uses steam (or electricity) introducing relevant data. When introducing data in the different devices (boilers, chillers, cooling chambers, washing processes, etc.) you can define the operation conditions. As a result, BC delivers a Map of Energy Use, with all energy flows and the energy balance. Thus, it is possible to assess both utilities and production processes. The main energy performance indicator is in a percentage shape that shows the amount of useful energy of the process comparing it with the total energy produced. To finish with the simulation, you can add a range of Energy Efficiency Measures such as the installation of solar thermal or solar photovoltaic panels, CHP, adding heat exchangers in order to decrease the energy production required (by means of a Pinch analysis), among others. It is possible to visualize not only the energy savings but also economic savings so it also takes into account economic benefits.

General information					
3					
Name:	EINSTEIN Tool-Kit				
Region:	Spain, Germany		Year:	2012	
Author/s:	energyXperts.NET		Editor/s:		
Language/s:	English		Format:		
Link:	http://einstein.sourceforge.net/				
Accessibility and ease of use					
Public available:	Yes: X		No:		
Comments:	A free version of the Einstein Tool-Kit is publicly available on http://einstein.sourceforge.net/ It is also possible to download the EINSTEINplus.				
Self-guiding:	Yes: X		No:		
Comments:	The EINSTEIN methodology is supported by an expert system software tool that guides the auditing procedure. You can also find some example projects.				
Conformity with National/Local legislation or Standards					
Name:					
Region:	National		Local:		
Authority:					
Conformity:	Yes:		No:		
Comments:	Not applied				
Conformity with European legislation or (International) Standards					
Name:					
Region:	European:		International:		
Authority:					
Conformity:	Yes:		No:		
Comments:	Not applied				
Aspects covered: STEAM (mark with an "X" and specify when required)					
Steam Production					X

Steam Distribution	X
Steam Use	X
Subject:	
Technologies	X
Operation	X
Control	X
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others *Please specify:*	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Assessment of production processes and utilities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	X
Non Energy Benefits	
Others *Please specify*	
Material content	

Similarly to BranchConcept (with boilers, cooling supply, etc.), perhaps more sophisticated, EINSTEIN functions are: main menu options, data entry, Consistency Check Module, Benchmark Module, Energy Statistics, Pinch Analysis, Heat Recovery Module, Heat and Cold Supply Modules, Energy Performance, Economic Analysis, Comparative Analysis, Report Generation.

General information			
4			
Name:	Chiarimenti in materia di diagnosi energetica nelle imprese		
Region:	Italy	Year:	2015
Author/s:	Italian Ministry of Economic Development	Editor/s:	
Language/s:	Italian	Format:	PDF
Link:	http://www.sviluppoeconomico.gov.it/index.php/it/energia/efficienza-energetica/diagnosi-energetiche		

Accessibility and ease of use				
Public available:	Yes:	✓	No:	
Comments:				
Self-guiding:	Yes:	✓	No:	
Comments:	It is an official guideline issued by Italian Ministry of Economic Development, to facilitate the implementation of EU EED			

Conformity with National/Local legislation or Standards				
Name:	Italian Energy Efficiency Decree-law (Lgs. Decree 102/2014)			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:	x	No:	
Comments:	The Italian Decree-law for implementing Directive 2012/27/ EU			

Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:		International:	x
Authority:				
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	

Steam Distribution	
Steam Use	
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* General approach for industrial energy auditing	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Assessment of production processes and utilities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others (*Please specify):* Including a number of case studies, of which one is related to the heat recovery from a steam boiler .	
Material content	

Please summarize the content (table of content): – Identification of the subject of the obligation: large companies and companies with a strong energy consumption – Identification of the subject of the obligation: the production site – Identification of the subjects who perform audit – Identification of technical procedures to implement the diagnoses – Deadline to diagnose, disclosure and other obligations – Sanctions – Communication of the savings

General information			
5			
Name:	EFFICIENZA ENERGETICA NEL SETTORE INDUSTRIALE		
Region:	Italy	Year:	2012
Author/s:	Giuseppe Nigliaccio	Editor/s:	ENEA
Language/s:	Italian	Format:	PDF
Link:	www.unindustria.treviso.it/confindustria/treviso/istituzionale.nsf/attach/674040DDF1454383C1257AAD003C5A1C/$File/G.Nigliaccio.pdf?OpenElement		

Accessibility and ease of use				
Public available:	Yes:	✓	No:	
Comments:				
Self-guiding:	Yes:		No:	✓
Comments:	It is a presentation made during a training course addressed to energy managers in industrial sectors			
Conformity with National/Local legislation or Standards				

Name:	Italian Energy Efficiency Decree-law (Lgs. Decree 102/2014)			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:	x	No:	
Comments:	The Italian Decree-law for implementing Directive 2012/27/ EU			
Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:	x	International:	
Authority:	European Commission			
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* General approach for industrial energy auditing, including casa studies, of which the heat recovering from steam boiler	x
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	x
Tasks, Responsibilities, Authorities	

Assessment of production processes and utilities	x
Operational Control (incl. maintenance)	
Monitoring and Verification	x
(Energy) Performance Indicators	x
Energy Management System	x
Identification of Energy Efficiency Measures	x
Financial Assessment and Procedures (SPP, LCC, IRR,…)	x
Non Energy Benefits	
Others (*Please specify):* Including a number of case studies, of which one is related to the heat recovery from a steam boiler .	x
Material content	
Please summarize the content (table of content): – Industrial energy auditing ○ Energy balance, energy use models ○ The approach of an industrial energy auditing ○ Final reporting ○ Possible EE measures: horizontal and vertical ones, with examples and casa studies, such as, heat recovering from steam generator, installation of steam turbine, heat recovering from CHP	

General information			
6			
Name:	Il Manuale delle migliori prassi per l’efficienza energetica Prassi 4 Come Migliorare le Performance del Generatore di Vapore		
Region:	Europe	Year:	2010
Author/s:	Project CARE+	Editor/s:	IEE Library
Language/s:	Italian	Format:	PDF

Link:	http://www.cefic.org/Documents/IndustrySupport/RC%20tools%20for%20SMEs/CARE+Best-Practices-in-Italian.pdf			
Accessibility and ease of use				
Public available:	Yes:	✓	No:	
Comments:				
Self-guiding:	Yes:	✓	No:	
Comments:	This guidebook is one of results obtained by IEE project CARE+			
Conformity with National/Local legislation or Standards				
Name:	Italian Energy Efficiency Decree-law (Lgs. Decree 102/2014)			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:	x	No:	
Comments:	The Italian Decree-law for implementing Directive 2012/27/ EU			
Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:	x	International:	
Authority:	European Commission			
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			
Aspects covered: STEAM (mark with an "X" and specify when required)				
Steam Production				x
Steam Distribution				x
Steam Use				x
Subject:				
Technologies				x
Operation				x
Control				x

Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* General approach for industrial energy auditing, including casa studies, of which the heat recovering from steam boiler	x
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	x
Tasks, Responsibilities, Authorities	
Assessment of production processes and utilities	x
Operational Control (incl. maintenance)	
Monitoring and Verification	x
(Energy) Performance Indicators	x
Energy Management System	x
Identification of Energy Efficiency Measures	x
Financial Assessment and Procedures (SPP, LCC, IRR,…)	x
Non Energy Benefits	
Others (*Please specify):* Including a number of case studies, of which one is related to the heat recovery from a steam boiler .	x
Material content	

Please summarize the content (table of content): – How to improve the performance of steam generator ○ Energy savings in the generation and distribution of steam ○ Pressure and temperature for steam generation ○ Heat losses of a Boiler ○ Energy consumption of boiler room ○ Radiation losses ○ Operation of the degasser ○ Boiler purging ○ Distribution of Steam ○ Boiler Return of Condensate ○ Inspect and Repair of condensate traps ○ Use the requirements of Steam Base Load to Generate (Part) energy consumption ○ Optimizing Water Treatment ○ List of Recommended Interventions

General information			
7			
Name:	Steam system services - Audit		
Region:	Italy	Year:	2015
Author/s:	Spirax Scarco Italia	Editor/s:	
Language/s:	Italian	Format:	PDF
Link:	http://www.spiraxsarco.com/global/italy/Products/Documents/Servizi%20per%20sistemi%20vapore.pdf		

Accessibility and ease of use				
Public available:	Yes:	✓	No:	
Comments:				
Self-guiding:	Yes:		No:	✓
Comments:	It is one of Spirax Sarco leaflets, where an example of energy audit is given.			

Conformity with National/Local legislation or Standards				
Name:	Italian Energy Efficiency Decree-law (Lgs. Decree 102/2014)			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:	x	No:	
Comments:	The Italian Decree-law for implementing Directive 2012/27/ EU			
Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:	x	International:	
Authority:	European Commission			
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* General approach for steam system energy auditing	x
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	

Assessment of production processes and utilities	
Operational Control (incl. maintenance)	
Monitoring and Verification	x
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	x
Financial Assessment and Procedures (SPP, LCC, IRR,…)	x
Non Energy Benefits	
Others (*Please specify):* Including a number of case studies, of which one is related to the heat recovery from a steam boiler .	x
Material content	
Please summarize the content (table of content): – Industrial steam system energy auditing approach ○ Case studies	

General information			
8			
Name:	Diagnosi energetica		
Region:	Italy	Year:	2008
Author/s:	Bruno Carraffa	Editor/s:	Asso EgE
Language/s:	Italian	Format:	PDF
Link:	http://www.informa.calabria.it/download/761.html		
Accessibility and ease of use			

Public available:	Yes:	✓	No:	

Comments:				
Self-guiding:	Yes:	✓	No:	
Comments:	It is a well done presentation made during a workshop on energy auditing, the general energy auditing approach was described			
Conformity with National/Local legislation or Standards				
Name:	Energy Efficiency Decree-law (Lgs. Decree 102/2014)			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:	x	No:	
Comments:	The Italian Decree-law for implementing Directive 2012/27/ EU			
Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:	x	International:	
Authority:	European Commission			
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	
Steam Distribution	
Steam Use	
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* General approach for industrial energy auditing	x

Aspects covered: Energy Auditing (mark with an “X” and specify when required)	
Management commitment (policy, resources,…)	x
Mapping of Energy Use (Energy Flows, Energy Balance,…)	x
Tasks, Responsibilities, Authorities	x
Assessment of production processes and utilities	x
Operational Control (incl. maintenance)	x
Monitoring and Verification	x
(Energy) Performance Indicators	x
Energy Management System	x
Identification of Energy Efficiency Measures	x
Financial Assessment and Procedures (SPP, LCC, IRR,…)	x
Non Energy Benefits	
Others (*Please specify):* the general energy auditing approach	x
Material content	

Please summarize the content (table of content):

- European directives and national legislation or Standards related to energy efficiency
- Industrial energy auditing
    - EE measures
    - The approach of an industrial energy auditing
        - Standard UNI CEI TR 11428/11 for data collection, IEP/IOP calculation, identification of the propriety of EE measures
        - Benchmark of reference
        - On-site data collection, process analysing, data elaboration,
        - Energy balance
        - Performance indicators' calculation
        - Data comparative analysis through benchmark reference
        - Identification possible EE measures
        - Technical-economic analysis of EE measures
        - Reporting of auditing results
        - Monitoring
        - Good practice examples

General information			
9			
Name:	Energy Assessment for Steam Systems		
Region:	American National Standard	Year:	2010
Author/s:	EA industrial system energy assessment standards committee	Editor/s:	The American Society of Mechanical Engineers
Language/s:	English	Format:	PDF
Link:	https://cstools.asme.org/csconnect/FileUpload.cfm?View=yes&ID=32720		

Accessibility and ease of use				
Public available:	Yes:	✓	No:	
Comments:				
Self-guiding:	Yes:	✓	No:	
Comments:				

Conformity with National/Local legislation or Standards				
Name:	Italian Energy Efficiency Decree-law (Lgs. Decree 102/2014)			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:	x	No:	
Comments:	The Italian Decree-law for implementing Directive 2012/27/ EU			

Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:	x	International:	
Authority:	European Commission			
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			

Aspects covered: STEAM (mark with an “X” and specify when required)	
Steam Production	x
Steam Distribution	x

Steam Use	x
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* *American National standard for energy assessment of steam systems, which defines the standardised approach for implementing energy audit of steam systems, indicates also a number of useful software tools as key references, for instance,* ***Steam System Assessment Tool***	x
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	x
Tasks, Responsibilities, Authorities	
Assessment of production processes and utilities	x
Operational Control (incl. maintenance)	x
Monitoring and Verification	x
(Energy) Performance Indicators	
Energy Management System	x
Identification of Energy Efficiency Measures	x
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others (*Please specify):* *American National standard for energy assessment of steam systems, which defines the standardised approach for implementing energy audit of steam systems, indicates also a number of useful software tools as key references, for instance,* ***Steam System Assessment Tool***	

Material content
Please summarize the content (table of content): • Organizing the assessment • Conducting the assessment • Assessment data analysis • Report and documentation

General information				
10				
Name:	Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities			
Region:	USA	Year:	2010	
Author/s:	Hasanbeigi, A. and Price, L.,	Editor/s:	Ernest Orlando Lawrence Berkeley National Laboratory	
Language/s:	English	Format:	PDF	
Link:	http://eetd.lbl.gov/node/49461			
Accessibility and ease of use				
Public available:	Yes:	✓	No:	
Comments:				
Self-guiding:	Yes:	✓	No:	
Comments:	General approach for industrial energy auditing			
Conformity with National/Local legislation or Standards				
Name:	Italian Decree-law n. 102/2014			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:	x	No:	

Comments:	The Italian decree-law for implementing the EED			
Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:	x	International:	x
Authority:				
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			

Aspects covered: STEAM (mark with an “X” and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	x
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* EE improvement opportunities in steam systems	x
Aspects covered: Energy Auditing (mark with an “X” and specify when required)	
Management commitment (policy, resources,…)	x
Mapping of Energy Use (Energy Flows, Energy Balance,…)	x
Tasks, Responsibilities, Authorities	x
Assessment of production processes and utilities	x
Operational Control (incl. maintenance)	x
Monitoring and Verification	x
(Energy) Performance Indicators	x
Energy Management System	x

Identification of Energy Efficiency Measures	x
Financial Assessment and Procedures (SPP, LCC, IRR,…)	x
Non Energy Benefits	
Others (*Please specify):* List of sector-specific energy-efficiency improvement opportunities for selected industrial sectors, including Textile and Fruit-vegetable processing industries where exist steam systems.	x
Material content	
Please summarize the content (table of content): – Introduction to industrial energy auditing – Preparation for the energy audit – Analysing energy bills – Inventory and measurement of energy use – Analysing energy use and production patterns – Benchmarking and comparative energy performance analysis – Identifying energy efficiency and energy cost reduction opportunities – Cost-benefit analysis of energy-efficiency opportunities – Preparing an energy audit report – Pot-audit activities – Appendixes: Conversion factors, Audit instruments, list of sector-specific EE improvement opportunities	

General information			
11			
Name:	An Energy Audit Manual and Tool		
Region:	Canada	Year:	2007
Author/s:		Editor/s	Canadian Industry Program for Energy Conservation (CIPEC) and the Office of Energy Efficiency of Natural Resources
Language/s:	English	Format:	PDF

Link:	www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/pdf/publications/infosource/pub/cipec/energy-audit-manual-and-tool.pdf			
Accessibility and ease of use				
Public available:	Yes:	✓	No:	
Comments:				
Self-guiding:	Yes:	✓	No:	
Comments:	Systems Approach to Energy Auditing			
Conformity with National/Local legislation or Standards				
Name:	Italian decree-law n. 102/2014			
Region:	National	x	Local:	
Authority:	Italian Government			
Conformity:	Yes:		No:	
Comments:	The Italian decree-law for implementing the EED			
Conformity with European legislation or (International) Standards				
Name:	Energy Efficiency Directive (Directive 2012/27/ EU)			
Region:	European:		International:	x
Authority:				
Conformity:	Yes:	x	No:	
Comments:	According to the EED, large companies will make audits of their energy consumption to help them identify ways to reduce it			
Aspects covered: STEAM (mark with an "X" and specify when required)				
Steam Production				x
Steam Distribution				x
Steam Use				x
Subject:				
Technologies				
Operation				
Control				
Good House Keeping (incl. maintenance, parameter setting,…)				

Monitoring	
Others (*Please specify):* Good practices	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	x
Tasks, Responsibilities, Authorities	x
Assessment of production processes and utilities	x
Operational Control (incl. maintenance)	x
Monitoring and Verification	x
(Energy) Performance Indicators	x
Energy Management System	x
Identification of Energy Efficiency Measures	x
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others (*Please specify) :* A step-by-step guide to the audit methodology	
Material content	

Please summarize the content (table of content):

- Introduction to energy auditing in industrial facilities
- Preparing for the audit
- A Step-by-Step guide to the audit methodology
- Energy analysis methods
    - Analyse energy consumption and costs
    - Comparative analysis
    - Profile energy use patterns
    - Inventory energy use
    - Identify energy management opportunities
    - Assess the costs and benefits
    - Report for action
- Technical supplement
    - Energy fundamentals
    - Details of energy-consuming systems
    - Condition survey checklists
    - Instrumentation for energy auditing
    - Electrical inventory method

General information			
12			
Name:	Energy Potential Scan		
Region:	Netherlands, Russia	Year:	2010
Author/s:	RVO	Editor/s:	Energy Experts International
Language/s:	English	Format:	pdf
Link:	http://eei.nl/download/Energy%20Potential%20Scan.pdf		

Accessibility				
Public available:	Yes: X		No:	
Comments:				

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	
Steam Distribution	
Steam Use	
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others *Please specify: Energy saving*	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	X
Mapping of Energy Use (Energy Flows, Energy Balance,…)	X
Tasks, Responsibilities, Authorities	X
Operational Control (incl. maintenance)	
Monitoring and Verification	X

(Energy) Performance Indicators	X
Energy Management System	X
Identification of Energy Efficiency Measures	X
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	
Material content	
Pdf-document where the EPS (Energy Potential Scan) is explained	
Training activities	
Steam Trainings based on the EPS may be available, but are normally custom made.	

General information				
13				
Name:	Generiek Stoommodel (Eng.: Generic Steam model)			
Region:	The Netherlands	Year:	2005 Updated 2014	
Author/s:	RVO, AKZO	Editor/s:	Industrial Energy Experts	
Language/s:	Dutch and English	Format:	Excel-sheet	
Link:	www.rvo.nl/sites/default/files/bijlagen/Generiek%20stoommodel.xls			
Accessibility and ease of use				
Public available:	Yes:	X	No:	
Comments:				
Self-guiding:	Yes:		No:	X
Comments:	A guide is available (in Dutch and English) in pdf http://www.rvo.nl/sites/default/files/bijlagen/Handleiding%20generiek%20Stoommodelversie%201a_0.pdf			
Conformity with National/Local legislation or Standards				
Name:				
Region:	National		Local:	
Authority:				
Conformity:	Yes:		No:	
Comments:				
Conformity with European legislation or (International) Standards				
Name:				
Region:	European:		International:	
Authority:				
Conformity:	Yes:		No:	
Comments:				
Aspects covered: STEAM (mark with an "X" and specify when required)				
Steam Production				X
Steam Distribution				X

Steam Use	X
Subject:	
Technologies	X
Operation	X
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others *Please specify:*	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	X
Tasks, Responsibilities, Authorities	
Assessment of production processes and utilities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	X
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	
Material content	
Please summarize the content (table of content): The Generic STEAM Model generates a consumption analysis for a steam installations where the generation, distribution and consumption of steam is taken into account. It shows where the energy losses are and defines a total efficiency of the steam installation.	

General information				
14				
Name:	Model Stoomkosten (Eng.: Steam costs Model)			
Region:	The Netherlands	Year:	NA	
Author/s:	Stoomplatform	Editor/s:	Energy matters, Energy Technology Services	
Language/s:	Dutch	Format:	Excel-sheet	
Link:	http://www.stoomplatform.nl/Tools/Model-Stoomkosten			
Accessibility and ease of use				
Public available:	Yes:	X	No:	
Comments:				
Self-guiding:	Yes:	X	No:	
Comments:				
Conformity with National/Local legislation or Standards				
Name:				
Region:	National		Local:	
Authority:				
Conformity:	Yes:		No:	
Comments:				
Conformity with European legislation or (International) Standards				
Name:				
Region:	European:		International:	
Authority:				
Conformity:	Yes:		No:	
Comments:				
Aspects covered: STEAM (mark with an "X" and specify when required)				
Steam Production				X
Steam Distribution				

Steam Use	
Subject:	
Technologies	
Operation	X
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others *Please specify:*	
Aspects covered: Energy Auditing (mark with an “X” and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	X
Tasks, Responsibilities, Authorities	
Assessment of production processes and utilities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	X
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	
Material content	
Please summarize the content (table of content): The Steam Costs Model generates the steam costs for steam production based on all costs (water, persons, operation time, gas)	

General information			
15			
Name:	Rekensheet Methode stand by (Eng.: Excel sheet for stand by steam boiler)		
Region:	The Netherlands	Year:	NA
Author/s:	SAM	Editor/s:	Tanja Wolf
Language/s:	Dutch	Format:	Excel-sheet
Link:	http://www.stoomplatform.nl/Tools/Rekensheet-Methode-Stand-By-ketel		

Accessibility and ease of use				
Public available:	Yes:	X	No:	
Comments:				
Self-guiding:	Yes:	X	No:	
Comments:	A guide is available (in Dutch and English) in pdf			

Conformity with National/Local legislation or Standards				
Name:				
Region:	National		Local:	
Authority:				
Conformity:	Yes:		No:	
Comments:				

Conformity with European legislation or (International) Standards				
Name:				
Region:	European:		International:	
Authority:				
Conformity:	Yes:		No:	
Comments:				

Aspects covered: STEAM (mark with an “X” and specify when required)	
Steam Production	X
Steam Distribution	

Steam Use	
Subject:	
Technologies	
Operation	X
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	X
Monitoring	
Others *Please specify:*	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Assessment of production processes and utilities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	
Material content	
Please summarize the content (table of content): It defines system losses in a steam boiler that is standing by	

F..2 Information Sources and Training Materials

General information			
16			
Name:	Industrial Steam System Optimization (SSO) Experts Training		
Region:	worldwide	Year:	October 2012
Author/s:	Riyaz Papar, P.E., CEM, Hudson Technologies Company, USA Greg Harrell, Ph.D., P.E. EMSCAS, USA Ven Venkatesan, P.E., CEM, Hudson Technologies Company, USA	Editor/s:	UNIDO Marco Matteini
Language /s:	English	Format:	pdf
Link:	http://energyeficiency.clima.md/public/files/Constientzare/Seminare/081112/Experts_SSO_Manual.pdf		
Accessibility			
Public available:	Yes: x		No:
Comments:	Complete package of Tools is also available		
Aspects covered: STEAM (mark with an "X" and specify when required)			
Steam Production: x			
Steam Distribution x			
Steam Use: x			
Subject:			
Technologies: x			
Operation: x			
Control: x			

Good House Keeping (incl. maintenance, parameter setting,…): x	
Monitoring: x	
Others *Please specify:*	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…): x	
Mapping of Energy Use (Energy Flows, Energy Balance,…): x	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance): x	
Monitoring and Verification: x	
(Energy) Performance Indicators: x	
Energy Management System: x	
Identification of Energy Efficiency Measures: x	
Financial Assessment and Procedures (SPP, LCC, IRR,…): x	
Non Energy Benefits	
Others *Please specify*	
Material content	

Fundamentals of steam systems Scoping the industrial steam system Modelling the industrial steam system Steam generation optimization opportunities Steam end use optimization opportunities Steam condensate recovery optimization opportunities CHP Steam system assessment protocol Portable instruments for assessment Steam system assessment report Case studies Conclusions and next steps
Training activities
Trainings within UNIDO projects

General information					
17					
Name:	Steam System Survey Guide				
Region:	US		Year:	2002	
Author/s:	Greg Harrel		Editor/s:	U.S. Department of Energy BestPractices Steam Program	
Language/s:	English		Format:	pdf	
Link:	http://energy.gov/eere/amo/recent-publications				
Accessibility					
Public available:	Yes:			No: x	
Comments:					
Aspects covered: STEAM (mark with an "X" and specify when required)					
Steam Production: x					
Steam Distribution x					
Steam Use: x					
Subject:					
Technologies: x					
Operation: x					
Control: x					
Good House Keeping (incl. maintenance, parameter setting,…): x					
Monitoring: x					
Others *Please specify:*					
Aspects covered: Energy Auditing (mark with an "X" and specify when required)					
Management commitment (policy, resources,…):					
Mapping of Energy Use (Energy Flows, Energy Balance,…):					
Tasks, Responsibilities, Authorities					

Operational Control (incl. maintenance): x	
Monitoring and Verification:	
(Energy) Performance Indicators: x	
Energy Management System:	
Identification of Energy Efficiency Measures: x	
Financial Assessment and Procedures (SPP, LCC, IRR,…):	
Non Energy Benefits	
Others *Please specify*	
Material content	

Training activities

-

18. Carbon Trust (2003): ECG066, Energy Consumption Guide, Steam Generation Costs 2003 (Update), Actionenergy from Carbon Trust

19. Carbon Trust (2004) ECG092, Energy Consumption Guide, Steam Distribution Costs, 2004 (Update), Actionenergy from Carbon Trust

20. Europäische Kommission (2009): Reference Documents on Best Available Techniques on Energy Efficiency

21. University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 2, Boilers and Furnaces, The Energy Research Institute

22. University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 5, Steam Systems, The Energy Research Institute

23. University of Cape Town (o.J): Energy Efficiency Earnings, Guide Book 6, Insulation, The Energy Research Institute

General information			
24			
Name:	Grundlagen der Dampf- und Kondensattechnologie Basics of steam and condensate technology		
Region:	Germany, Switzerland, Austria	Year:	2006
Author/s:	Spirax Sarco	Editor/s:	Spirax Sarco
Language/s:	German	Format:	pdf
Link:	http://www2.spiraxsarco.com/ch/ger/pdfs/grundlagen/grundlagen-der-dampf-und-kondensattechnologie.pdf		

Accessibility				
Public available:	Yes: x		No:	
Comments:				

Aspects covered: STEAM (mark with an “X” and specify when required)	
Steam Production: x	
Steam Distribution x	
Steam Use: x	
Subject:	
Technologies: x	
Operation: x	
Control: x	
Good House Keeping (incl. maintenance, parameter setting,…): x	
Monitoring: x	

Others *Please specify:*	
Aspects covered: Energy Auditing (mark with an “X” and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance): x	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures: x	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	
Material content	
Was ist Dampf? Dampfanlage Dampferzeugung Dampfleitung Behandlung von Dampf Wärmetausch Entwässerung von Dampfräumen, Kondensatableiter Kondensatleitung Kondensatwirtschaft Regelsysteme Planung, Bau, Inbetriebnahmen, Fehlersuche	
Training activities	

Costumer trainings

25. Spirax Sarco (2007). Leitfaden für die Gestaltung von Dampf- und Kondensatnetzen, die Auswahl und den Einbau von Kondensatableitern, die Fehlersuche in Dampf- und Kondensatnetzen, den Betrieb von Dampf- und Kondensatanlagen, Konstanz

26. Sattler, P., Fuchsberger, K., Hinterndorfer, M,: Einsparpotentiale in der industriellen Dampferzeugung und –anwendung im Auftrag des Landesenergieverein Steiermark, 2009

General information			
27			
Name:	Heat Module of the European Energy Manager (EUREM) Course		
Region:	Spain	Year:	2014-2015
Author/s:	Escan s.l.	Editor/s:	
Language/s:	Spanish	Format:	
Link:			

Accessibility				
Public available:	Yes:		No: X	
Comments:				

Aspects covered: STEAM (mark with an “X” and specify when required)	
Steam Production	X
Steam Distribution	
Steam Use	X
Subject:	
Technologies	X
Operation	X
Control	X
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	X
Others *Please specify:*	

Aspects covered: Energy Auditing (mark with an “X” and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,….)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	X
Monitoring and Verification	

(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	X
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	

Material content

The Heating Module of the EUREM course is focused on Heating systems (central heating, district heating...). As regards heating generation, it includes boilers and burners, heating pumps and other heating generation elements. Other components of a heating installation (distribution networks, heat recovery systems, etc.).

- Regulation: basic regulation according to esternal/internal temperature, telemanagement, multisystem.

- Fuels (solids, liquids, gases, solar energy, biomass, electricity)

- Maintenance (Predictive, preventive, corrective)

- Energy Efficiency in heating (Building envelope, existent installations)

- Efficient industrial systems (main equipements, fuels, boilers, design, operation and maintenance)

- Security and environment (security in operation, impact on the environment, condensante recuperation)

- Improvement of the combustion equipement efficiency.

- Waste heat recuperation in processes

Training activities

General information			
28			
Name:	Greenfoods Training – Heating Systems and Optimisation		
Region:	Spain	Year:	2015
Author/s:	Francisco Puente, Escan, s.l.	Editor/s:	
Language/s:	English	Format:	
Link:	http://www.green-foods.eu/		

Accessibility				
Public available:	Yes:		No: X	
Comments:				

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	X
Steam Distribution	
Steam Use	
Subject:	
Technologies	X
Operation	X
Control	X
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	X
Others *Please specify:*	

Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	X
Monitoring and Verification	

(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	X
Financial Assessment and Procedures (SPP, LCC, IRR,…)	X
Non Energy Benefits	X
Others *Please specify*	
Material content	
This part of the Greenfoods training module develops the heating systems typically used in food and beverage industries, which include hot water and steam production industrial boilers. The content include a brief introduction to water and steam boilers, operational behaviours in steam boilers, efficiency improvements (economizers, heat recovery from purges of salts and sludges, boiler envelope insulation, condensates heat recovery, control system, etc.).	
Training activities	

13.

General information			
29			
Name:	Thermo- technic plants		
Region:	Italy	Year:	2012
Author/s:	GIULIANO CAMMARATA	Editor/s:	University of Catania
Language/s:	Italian	Format:	PDF
Link:	http://www.diim.unict.it/users/gcamma/IMPIANTI%20TERMOTECNICI%20-%20VOLUME%203%20NO.pdf		

Accessibility				
Public available:	Yes:		No:	x
Comments:	Training lesson organised for experts working on thermo-technical planta			

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	x
Subject:	
Technologies	x
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* Lesson is related to the use of steam, not for energy auditing	

Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	

Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others(*Please specify) :* Lesson related to thermal plant operators, but not for energy auditing	
Material content	
Training topics: – Distribution networks of water and air – Movement of bi-phase fluids – Stability of heating pipe – Distribution networks of steam – Distribution networks of compressed air – And cogeneration and trigeneration – Antifire systems – Noise in mechanical systems	
Training activities	

General information			
30			
Name:	Lesson of 'Study and utilization steam'		
Region:	Italy	Year:	14/10/2015
Author/s:	-	Editor/s:	Spixa Sarco
Language/s:	Italian	Format:	PDF
Link:	http://www.spiraxsarco.com/global/italy/Training/Pages/Studio-ed-utilizzo-degli-impianti-vapore.aspx.it/Entra/Engine/RAServeFile.php/f/P004271/allegati_ins/Generatori_di_vapore_1.pdf		

Accessibility				
Public available:	Yes:		No:	x
Comments:	Payment training lesson organised for technical designers, installers and operating responsible persons			

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	
Subject:	
Technologies	x
Operation	
Control	

Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* Lesson is related to the use of steam, not for energy auditing	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others(*Please specify) :* Lesson related to steam generator, but not for energy auditing	
Material content	
Training topics: – Physical principles of steam – Generation: boilers features and water treatment – Steam distribution networks and condensate recovery – Traps: operating principles, choice and – sizing – Drainage of thermo-regulated equipment – The flash steam and energy considerations – Recovery systems – Reduction of self-activated pressure – Setting of self-activated temperature	
Training activities	

Spirax Sarco organises periodically training activities for steam experts. For 2015, a big number of lessons are foreseen for experts working in different industrial sectors.

General information					
31					
Name:	Lesson of 'The heat exchange and heat exchangers'				
Region:	Italy		Year:	04/11/2015	
Author/s:	-		Editor/s:	Spixa Sarco	
Language/s:	Italian		Format:	PDF	
Link:	http://www.spiraxsarco.com/global/italy/Training/Pages/Lo-scambio-termico-e-gli-scambiatori-di-calore.aspx				
Accessibility					
Public available:	Yes:		No:		x
Comments:	Payment training lesson about physical principles and techniques of steam utilisation				

Aspects covered: STEAM (mark with an “X” and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	x
Subject:	
Technologies	x
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others (*Please specify):* Lesson is related to the use of steam, not for energy auditing	
Aspects covered: Energy Auditing (mark with an “X” and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others(*Please specify) :* Lesson related to steam generator, but not for energy auditing	
Material content	

Training topics: – Thermodynamics: definitions and sizes – Physical principles of heat exchange – Configurations of flow and variables that influence exchange – Types, configurations, design and construction codes – What you need to know the European standard – Construction materials, corrosion and vibration – Innovative technology of corrugated to steam generation and the related advantages – Innovation and solution of complex problems by means of the combination of 'plates & shell" – The series of preconfigured and calculation programs and optimization – Typical applications in industrial field
Training activities
Spirax Sarco organises periodically training activities for steam experts. For 2015, a big number of lessons are foreseen for experts working in different industrial sectors.

General information			
32			
Name:	Lesson of 'Energy use in industry' – Steam generator		
Region:	March	Year:	2009
Author/s:	-	Editor/s:	Polytechnic University of March
Language/s:	Italian	Format:	PDF
Link:	http://www.univpm.it/Entra/Engine/RAServeFile.php/f/P004271/allegati_ins/Generatori_di_vapore_1.pdf		

Accessibility				
Public available:	Yes:		No:	x
Comments:	Lesson of steam generator for university students			

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	
Subject:	
Technologies	x
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others *Please specify:* All principles and technology development of steam generator	

Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	
Monitoring and Verification	

(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others(*Please specify) :* Lesson related to steam generator, but not for energy auditing	
Material content	
Steam generator – Elementary Circuit – Characteristics – Technological evolution – The main components and the heat exchange – Combustion temperature – Efficiency – Thermal load – The circulation of the evaporating fluid	
Training activities	

General information					
33					
Name:	Lesson of 'Heat recovery Steam generator'				
Region:	Lombardia		Year:	1986	
Author/s:	Elio Mazzi		Editor/s:	Polytechnic University of Milan	
Language/s:	Italian		Format:	PDF	
Link:	http://www.costanteinvernizzi.it/Site_1/Downlodable_Documents_4_files/generatori_di_vapore_Mazzi1.pdf				
Accessibility					
Public available:	Yes:	x	No:		
Comments:	Lesson of steam generator for university students				
Aspects covered: STEAM (mark with an "X" and specify when required)					
Steam Production					
Steam Distribution					
Steam Use					
Subject:					
Technologies					
Operation					
Control					

Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others *Please specify:* All principles and technology development of steam generator	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others(*Please specify) :* Lesson related to steam generator, but not for energy auditing	
Material content	
All principles about heat recovery steam generator	
Training activities	

General information			
34			
Name:	Modern Industrial Assessments: A Training Manual		
Region:	US	Year:	2001
Author/s:	US DOE	Editor/s:	RUTGERS
Language/s:	English	Format:	PDF
Link:	https://iac.rutgers.edu/manual_industrial.php		
Accessibility			
Public available:	Yes: x	No:	
Comments:	Chapter 5: Heat, where steam system assessment is described.		

Aspects covered: STEAM (mark with an "X" and specify when required)	
Steam Production	
Steam Distribution	
Steam Use	
Subject:	
Technologies	
Operation	
Control	
Good House Keeping (incl. maintenance, parameter setting,…)	
Monitoring	
Others *Please specify:* Boiler energy assessment methodology	
Aspects covered: Energy Auditing (mark with an "X" and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,…)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	
Monitoring and Verification	
(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	
Material content	

- Boiler operation and efficiency
  - Boiler efficiency tips
  - Combustion in boilers: complete and incomplete combustion, calculating combustion efficiency
  - Adjustment of fire and air ratio: case studies
- Elimination of steam leaks
- Maintenance of steam traps
- High pressure condensate return systems
- Variable Frequency Drives for Combustion Air Blowers
- Heat recovery systems
- Heat systems: case study

Training activities

General information			
35			
Name:	Best Practice Steam		
Region:	Netherlands	Year:	2015
Author/s:	RVO	Editor/s:	Industrial Energy Experts
Language/s:	Dutch	Format:	pdf
Link:	Not available yet --> concept is pending		
Accessibility			
Public available:	Yes: X		No:
Comments:	In concept available		

Aspects covered: STEAM (mark with an “X” and specify when required)	
Steam Production	x
Steam Distribution	x
Steam Use	x
Subject:	
Technologies	x
Operation	x
Control	x
Good House Keeping (incl. maintenance, parameter setting,…)	x
Monitoring	x
Others *Please specify: Energy saving*	x
Aspects covered: Energy Auditing (mark with an “X” and specify when required)	
Management commitment (policy, resources,…)	
Mapping of Energy Use (Energy Flows, Energy Balance,….)	
Tasks, Responsibilities, Authorities	
Operational Control (incl. maintenance)	
Monitoring and Verification	

(Energy) Performance Indicators	
Energy Management System	
Identification of Energy Efficiency Measures	
Financial Assessment and Procedures (SPP, LCC, IRR,…)	
Non Energy Benefits	
Others *Please specify*	
Material content	
Pdf document with all technical and good housekeeping aspects for energy saving in all aspects off the Steam system. From water treatment, burners, till monitoring.	
Training activities	
Self employed	

- http://www.bmwi.de/EN/Topics/Energy/energy-efficiency.html
- http://www.deneff.org/
- http://www.isi.fraunhofer.de/isi-de/index.php